W. B. No. 647

U. S. DEPARTMENT OF AGRICULTURE

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CHARLES F. MARVIN, Chief

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CONTENTS.

NOTICE TO CONTRIBUTORS.

Contributions intended for publication in any given issue of the Monthly Weather Review (e. g., January) should be in the hands of the editor before the end of the next following month (e. g., February), if no illustrations are required. When the paper is illustrated, the manuscript and the copy for illustrations must be submitted much earlier, in order to permit copy being prepared for the engraver by the end of the month.

Reprints are made up without covers in the original size and pagination of the Review. They will not be furnished unless specifically REQUESTED WHEN THE MANUSCRIPT IS SUBMITTED.

MONTHLY WEATHER REVIEW

CLEVELAND ABBE, Jr., Editor.

VOL. 46, No. 4.
W. B. No. 647.

APRIL, 1918.

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INTRODUCTION.

As explained in this Introduction during 1914, the MONTHLY WEATHER REVIEW now takes the place of the Bulletin of the Mount Weather Observatory and of the voluminous publication of the climatological service of the Weather Bureau. The MONTHLY WEATHER REVIEW contains contributions from the research staff of the Weather Bureau and also special contributions of a general character in any branch of meteorology and climatology.

SUPPLEMENTS to the MONTHLY WEATHER REVIEW are published from time to time.

The climatological service of the Weather Bureau is maintained in all its essential features, but its publications, so far as they relate to purely local conditions, are incorporated in the monthly reports "Climatological Data" for the respective States, Territories, and colonies.

Since August, 1915, the material for the MONTHLY WEATHER REVIEW has been prepared and classified in accordance with the following sections:

SECTION 1.—*Aerology.*—Data and discussions relative to the free atmosphere.

SECTION 2.—*General meteorology.*—Special contributions by any competent student bearing on any branch of meteorology and climatology, theoretical or otherwise.

SECTION 3.—*Forecasts and general conditions of the atmosphere.*

SECTION 4.—*Rivers and floods.*

SECTION 5.—*Seismology.*—Results of observations by Weather Bureau observers and others as reported to the Washington office.

SECTION 6.—*Bibliography.*—Recent additions to the Weather Bureau library; recent papers bearing on meteorology.

SECTION 7.—*Weather of the month.*—Summary of local weather conditions; climatological data from regular Weather Bureau stations; tables of accumulated and excessive precipitation; data furnished by the Canadian Meteorological Service; monthly charts Nos. 1, 2, 3, 4, 5, 6, 7, 8, the same as hitherto; Meteorological Summary and chart No. 9 of the North Atlantic Ocean for this month in 1917. Owing to the fact that ocean meteorological data are frequently not available for a considerable time after the close of the month to which they relate, the chart and text matter in connection therewith appear one year late.

In general, appropriate officials prepare the seven sections above enumerated; but *all students of atmospherics are cordially invited to contribute such additional articles as seem to be of value.*

The voluminous tables of data and text relative to local climatological conditions, that during recent years were prepared by the 12 respective "district editors," are omitted from the MONTHLY WEATHER REVIEW, but are collected and published by States at selected section centers. (See cover, p. 3.)

The data needed in Section 7 can only be collected and prepared several weeks after the close of the month designated on the title-page; hence the REVIEW as a whole can only issue from the press within about eight weeks from the end of that month.

It is hoped that the meteorological data hitherto contributed by numerous independent services will continue as in the past. Our thanks are specially due to the directors and superintendents of the following:

The Meteorological Service of the Dominion of Canada.
The Meteorological Service of Cuba.
The Meteorological Observatory of Belen College, Habana.
The Government Meteorological Office of Jamaica.
The Meteorological Service of the Azores.
The Meteorological Office, London.
The Danish Meteorological Institute.
The Physical Central Observatory, Petrograd.
The Philippine Weather Bureau.

The Weather Bureau desires that the MONTHLY WEATHER REVIEW shall be a medium of publication for contributions within its field, but such publication is not to be construed as official approval of the views expressed.

CORRIGENDUM.

REVIEW, December, 1917:
Page 582, col. 1, equation (4): *for* $48\Delta p^2$ *read* $14\Delta p^2$.

SECTION I.—AEROLOGY.

SOLAR AND SKY RADIATION MEASUREMENTS DURING APRIL, 1918.

By Irving F. Hand, Temporarily in Charge Solar Radiation Investigations.

[Dated: Weather Bureau, Washington, D. C., May 31, 1918.]

For a description of instrumental exposures and an account of the methods of obtaining and reducing the measurements the reader is referred to the Review for January, 1918, **46**:2.

The monthly means and departures from normal values in Table 1, show that direct solar radiation averaged considerably above normal at Washington, D. C., and about normal at Madison, Lincoln, and Santa Fe.

Table 3 shows a deficiency of 12 per cent and 5 per cent, respectively, at Washington and Madison as compared with the normal radiation for April. The average for Lincoln was very close to normal.

The reading of 1.51 at air mass 1.19 on April 5 is the highest ever obtained at Washington. This value remains unchanged when corrected for radius vector, or mean solar distance. The rapid decrease in radiation during the afternoon of this date was undoubtedly due to the increasing dust and haze in the atmosphere, as the vapor pressures changed but little during the day.

Skylight polarization measurements obtained at Washington on 5 days give a mean of 60 per cent, with a maximum of 66 per cent on the 5th, which is as high as has been obtained in Washington during April since 1907. Measurements obtained at Madison also give a mean of 60 per cent, with a maximum of 68 per cent on the 23d.

Table 1.—*Solar radiation intensities, during April, 1918.*

[Gram-calories per minute per square centimeter of normal surface.]

Washington, D. C.

Date.	Sun's zenith distance.									
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
	Air mass.									
	1.0	1.5	2.0	2.5	.0	3.5	4.0	4.5	5.0	5.5
1918 A. M.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
April 2			0.95	0.89						
5	1.54	1.42	1.33	1.24	1.15	1.08	1.00	0.94	0.88	0.82
6	1.29	1.13	1.11	1.00	0.95		0.75	0.72	0.67	
15				0.76						
16		1.06								
17			0.77							
19		1.12	1.00	0.87	0.79	0.70			0.56	
22		1.24			0.91	0.85				
23	1.33	1.20								
24	1.23									
25	1.42	1.18								
Monthly means	**1.36**	**1.19**	**1.03**	**0.95**	**0.95**	**0.88**	**(0.88)**	**(0.83)**	**0.70**	**(0.82)**
Departure from 10-year normal	**+0.01**	**+0.02**	**−0.02**	**±0.00**	**+0.08**	**+0.07**	**+0.15**	**+0.10**	**+0.03**	**+0.17**
P. M.										
April 5		1.40	1.28	1.17	1.07	0.97	0.86	0.80	0.72	0.66
6		1.24	1.02							
14		1.32	1.17	1.03	0.93					
23		1.18								
25		1.20								
Monthly means		**1.27**	**1.16**	**(1.10)**	**(1.00)**	**(0.97)**	**(0.86)**	**(0.80)**	**(0.72)**	**(0.66)**
Departure from 10-year normal		**+0.06**	**+0.09**	**+0.11**	**+0.10**	**+0.13**	**+0.10**	**+0.20**	**+0.18**	

Table 1.—*Solar radiation intensities, during April, 1918*—Continued.

Madison, Wis.

Date.	Sun's zenith distance.									
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
	Air mass.									
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
1918 A. M.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Apr. 2		1.24								
3		1.39	1.31	1.23						
4		1.42	1.29	1.22	1.15	1.08	1.01	0.95	0.90	
10		1.47	1.35							
13			1.08	0.91	0.84					
23	1.41									
Monthly means	**(1.41)**	**1.38**	**1.26**	**1.12**	**(1.00)**	**(1.08)**	**(1.01)**	**(0.95)**	**(0.90)**	
Departure from 8-year normal	**+0.02**	**+0.04**	**+0.04**	**−0.01**	**−0.08**	**−0.02**	**−0.03**			
P. M.										
Apr. 4		1.42	1.29	1.18						
8		1.45	1.30							
10		1.47	1.34							
12		1.23	1.12							
23		1.31	1.19	1.09	1.04					
Monthly means		**1.38**	**1.25**	**(1.14)**	**(1.04)**					
Departure from 8-year normal		**+0.02**	**−0.02**	**−0.04**	**−0.06**					
Lincoln, Nebr.										
A. M.										
Apr. 1		1.21								
7		1.31	1.19	1.11	0.99	0.89	0.79			
9	1.45	1.35	1.25	1.15						
16	1.42	1.21		0.99	0.91	0.83	0.72			
18		1.28	1.16	1.03	0.95	0.88	0.81	0.75		
28		1.34	1.24	1.13	0.98	0.91	0.82			
30		1.44								
Monthly means	**(1.44)**	**1.28**	**1.21**	**1.08**	**0.96**	**0.88**	**0.78**	**(0.75)**		
Departure from 3-year normal	**−0.05**	**−0.07**	**−0.03**	**−0.04**	**−0.06**	**−0.04**	**−0.04**	**−0.10**		
P. M.										
Apr. 8		1.34	1.25	1.18	1.11	1.00	0.92	0.88	0.84	
9		1.35	1.25	1.15	1.07	1.00				
30		1.28	1.13	1.04	0.97	0.91	0.84	0.81	0.79	
Monthly means		**1.32**	**1.21**	**1.12**	**1.05**	**0.97**	**0.88**	**0.84**	**0.79**	
Departure from 3-year normal		**+0.02**	**+0.06**	**+0.07**	**+0.08**	**+0.07**	**+0.02**	**+0.02**	**+0.07**	
Santa Fe, N. Mex.										
A. M.										
Apr. 2	1.54	1.40								
4		1.43			1.09					
8		1.37			1.05	0.97				
9	1.39									
19			1.32	1.23	1.16	1.08				
22	1.49	1.37			1.11	1.03				
Monthly means	**1.47**	**1.39**	**(1.32)**	**(1.23)**	**1.10**	**1.03**				
Departure from 6-year normal	**−0.06**	**−0.04**	**−0.03**	**−0.02**	**−0.08**	**−0.09**				
P. M.										
Apr. 2		1.42								
8		1.35								
9		1.35	1.31							
21				1.21	1.12	1.04	1.01	0.94	0.89	
Monthly means		**1.44**	**(1.31)**	**(1.21)**	**(1.12)**	**(1.04)**	**(1.01)**	**(0.94)**	**(0.89)**	
Departure from 2-year normal		**+0.12**	**+0.18**	**+0.14**	**+0.12**	**+0.06**				

TABLE 2.—*Vapor pressures at pyrheliometric stations on days when solar radiation intensities were measured.*

Washington, D. C.			Madison, Wis.			Lincoln, Nebr.			Santa Fe, N. Mex.		
Date.	8 a. m.	8 p. m.	Date.	8 a. m.	8 p. m.	Date.	8 a. m.	8 p. m.	Date.	8 a. m.	8 p. m.
1918.	*mm.*	*mm.*	1918.	*mm.*	*mm.*	1918.	*mm.*	*mm.*	1918.	*mm.*	*mm.*
Apr. 2	9.83	8.48	Apr. 2	3.63	4.75	Apr. 1	2.74	4.75	Apr. 2	3.00	2.16
5	2.26	2.62	3	2.62	2.62	7	4.17	2.62	4	3.00	3.15
6	3.00	3.63	4	2.74	2.49	8	1.88	2.62	8	4.17	4.37
14	4.57	4.75	10	2.16	2.49	9	1.96	2.49	9	3.15	2.87
15	4.75	5.16	12	4.37	2.49	16	5.16	5.79	19	2.26	4.37
16	7.04	10.21	13	2.36	2.74	18	4.17	4.57	21	2.87	2.49
17	10.97	14.10	23	3.00	3.00	28	4.57	3.81	22	2.36	2.62
19	6.50	9.47	......	......	......	30	4.57	3.45	......	......	......
22	7.04	5.56	......	......	......	......	......	......	......	......	......
23	8.18	10.59	......	......	......	......	......	......	......	......	......
24	4.17	5.56	......	......	......	......	......	......	......	......	......
25	5.36	4.75	......	......	......	......	......	......	......	......	......

TABLE 3.—*Daily totals and departures of solar and sky radiation during April, 1918.*

[Gram-calories per square centimeter of horizontal surface.]

Day of month.	Daily totals.			Departures from normal.			Excess or deficiency since first of month.		
	Washington.	Madison.	Lincoln.	Washington.	Madison.	Lincoln.	Washington.	Madison.	Lincoln.
1918.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Apr. 1	380	524	542	−1	135	118	−1	135	118
2	473	371	233	90	−20	−182	89	115	−64
3	177	510	180	−208	117	−246	−119	232	−310
4	205	558	552	−183	163	124	−302	395	−186
5	634	511	120	243	114	−310	−59	509	−496
6	574	102	536	182	−297	105	123	212	−391
7	194	196	521	−200	−204	89	−77	8	−302
8	184	631	640	−212	229	207	−289	237	−95
9	44	606	638	−354	203	204	−643	440	109
10	75	643	596	−325	238	161	−968	678	270
11	41	444	643	−361	38	207	−1,329	716	477
12	206	575	559	−198	167	122	−1,527	883	599
13	267	571	563	−139	162	125	−1,666	1,045	724
14	615	516	236	207	105	−203	−1,459	1,150	521
15	568	416	261	158	3	−179	−1,301	1,153	342
16	406	306	572	−6	−110	131	−1,307	1,043	473
17	390	93	552	−24	−326	109	−1,331	717	582
18	311	183	456	−107	−239	11	−1,438	478	593
19	470	518	95	47	93	−351	−1,391	571	242
20	112	153	243	−315	−275	−204	−1,706	296	38
Decade departure							**−738**	**−382**	**−232**
21	281	78	390	−150	−353	−58	−1,856	−57	−20
22	442	566	478	6	132	28	−1,850	75	8
23	561	558	418	120	121	−34	−1,730	196	−26
24	585	611	432	140	171	−22	−1,590	367	−58
25	626	464	648	177	21	183	−1,413	388	125
26	383	398	249	−69	−47	−207	−1,482	341	−82
27	534	190	82	79	−256	−375	−1,403	85	−457
28	601	129	488	142	−319	30	−1,261	−234	−427
29	339	203	625	−123	−246	165	−1,384	−480	−262
30	338	259	684	−128	−192	223	−1,512	−672	−29
Decade departure							**+194**	**−968**	**−67**
Excess or deficiency since first of year. calories							**−995**	**+865**	**−579**
Excess or deficiency since first of year. per cent							−2.8	+2.4	−1.4

ABSORPTION AND RADIATION OF THE SOLAR ATMOSPHERE.

By SHIN HIRAYAMA.

[*Abstract reprinted from* Nature, London, Apr. 18, 1918, **101**:134.]

A paper by Prof. Shin Hirayama appears under this title in the Proceedings of the Tokyo Mathematico-Physical Society, second series, volume 9, page 236. Utilizing observations of the radiation from different parts of the solar disk which have been made by Abbot, Prof. Hirayama computes the transmission and radiation of the solar atmosphere, on Schuster's supposition that a great part of the solar radiation comes from an absorbing and radiating layer above the photosphere. It is shown that the observations are better represented in this way than by the previous calculations of Biscoe, in which the radiation of the atmosphere was not considered. The coefficient of transmission increases gradually with the wave-length, and the radiation due to the atmosphere ranges from one-third of the whole radiation for the shorter wave-lengths to nearly one-half as the wave-length increases. Assuming the effective temperature of the sun to be 6,000° Abs., it is calculated that the temperature of the photosphere is about 7,040°, while that of the absorbing layer is 5,210°

HALO OF APRIL 14, 1918, AT COLUMBUS, OHIO.[1]

By HOWARD H. MARTIN, Observer.

[Dated: Weather Bureau, Columbus, Ohio, April 19, 1918.]

A very complex and highly colored solar halo with four attendant parhelia and a vividly colored circumzenithal arc was observed at this station (lat. 39° 58′ N.; long. 83° 0′ W.) from 4:50 p. m. to 5:40 p. m., *Normal* 90th Meridian Time.

The accompanying drawing, figure 1, depicts the phenomenon as it appeared at the moment of greatest color and distinctness, viz, 5:12 p. m. The circumzenithal arc was visible from the moment of first appearance (4:50 p. m.) to about 5:02 p. m., and again from 5:08 p. m. to 5:15 p. m. Probably the most highly colored and brilliant of the four parhelia was that one observed at the junction of the upper bitangent arc of the 46°-halo and the circumzenithal arc. At the time of greatest intensity there was a faint coloring about the zenith, suggesting the presence of Kern's Arc, but the coloring faded without a well-defined appearance.

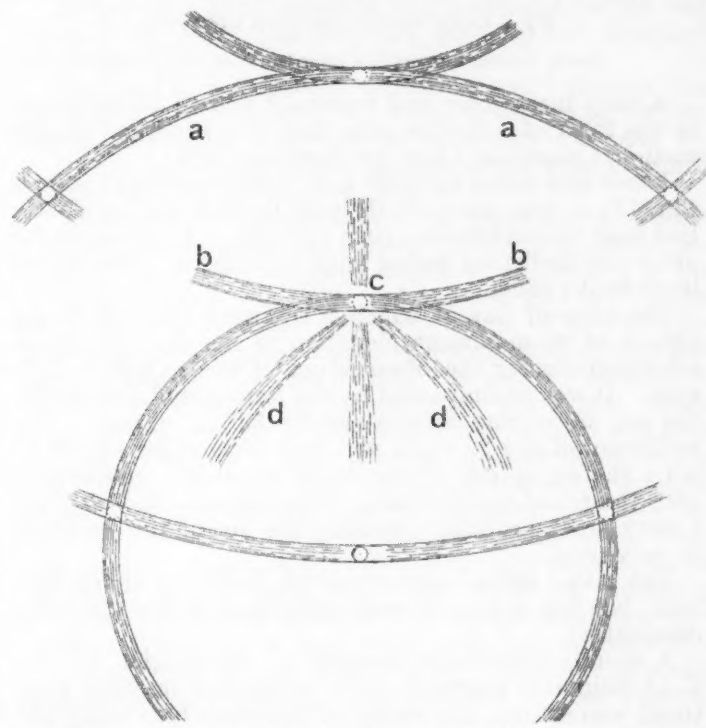


FIG. 1.—Solar halos observed at Columbus, Ohio, Apr. 14. 1918 (5:12 p. m. 90th M. T.).

A light pillar extended upward from the sun for a very short period of time subsequent to 5:10 p. m., and at the same time faint fragments of upper arcs of circumscribing halos were visible.

The halo occurred after a day of fine weather. A sudden movement of cirro-stratus from the southwest occurred between 3:30 p. m. and 6 p. m., with a stationary barometer and a temperature of 64°. The cloudiness passed as quickly as it came and the phenomenon was followed by no immediate weather change of note, although precipitation occurred during the subsequent 36 hours.

NOTE.

In the sketch, figure 1, furnished by Mr. Martin, there are indicated two very unusual forms, and in addition one

[1] Publication approved by Division of Aërological Investigations.

that does not seem to have been heretofore observed. The first two are those marked *aa* and *bb*, which apparently are the upper bitangent arc of a halo of 46° and part of a "secondary" parhelic circle, respectively. At the intersections of these two arcs were observed bright spots which might be called "secondary" parhelia of 46°. The "secondary" parhelic circle was probably caused by the vertical parhelion at *c*, which in turn was produced by the intersection of the light pillar and the 22° halo.

The arcs *dd* are difficult to account for. Possibly they are parts of an "eliptical helio-centric halo," similar to that observed by Hissink in 1901, and referred to by Besson, MONTHLY WEATHER REVIEW, July, 1914, p. 445, top of column 1.—*W. R. Gregg.*

INFERIOR ARC OF 46°-HALO, APRIL 25, 1918.[1]

By J. LAKE VESPER, Assistant Observer.

[Dated: Weather Bureau Office, Columbus, Ohio, May 20, 1918.]

A very interesting and unusual [2] optical phenomenon in the form of a double solar halo was observed at this station, Columbus, Ohio, on April 25, 1918.

When first noted at 11:50 a. m., 90th meridian summer time [?], it was exceedingly well defined and evidently had been visible for some time previous. Its duration for attractive brilliancy lasted until 12:40 p. m., after which it gradually faded.

The time of day at which it occurred (the sun being almost at its maximum elevation in the sky) was most advantageous for the observation of the complete 22°-halo. It was accompanied by the *lower arc* of a 46°-halo, the arc measuring approximately 50° in extent. The brilliancy of the 22°-halo was well defined for the 360°, with the exception of the lower segment symmetrical with the arc of the 46°-halo. This segment had attained a very great brilliancy, causing the arc of the 46°-halo to be visible.

The latter lacked somewhat the brilliancy of the 22°-halo, but the color was well defined, with the blue predominating.

A double solar halo observed at this station by Mr. T. G. Shipman, August 1, 1911, at 12:10 p. m. [90th mer. time], was similar, the radius of the outer halo being 46° and the inner 22°. Its coloring was very marked and beautiful.

Dr. Louis Besson, in his article, "The Different Forms of Halos and Their Observation" (this REVIEW, July, 1914, **42** : 438-9), states that the average frequency of such phenomena at Paris is eight days per annum, and in two-thirds of the cases only the superior portion of the 46°-halo is visible. This case of the lower arc is therefore a rare one and worth recording here.

ELLIPTICAL HALOS OF VERTICAL MAJOR AXIS.

By J. B. DALE.

(Craigness, New Malden, Surrey, Apr. 10, 1918.)

[*Reprinted from* Nature, London, Apr. 18, 1918, **101** : 126.]

The accepted explanation of the halos of 22° radius which are seen surrounding the sun and moon implies that they are exactly circular in form. About two years ago, however, I noticed a halo which appeared to be elliptical with the major axis vertical. I was unfortunately unable to take any measurements on that occasion, but on March 18, 1918, a lunar halo, which was visible for a considerable time during the evening, also appeared to possess a decided, though slight ellipticity. That this deviation from the circular form was not an illusion I was enabled to verify by noting the positions of Capella and γ Geminorum relative to the ring.

At 7:30 p. m. Capella appeared to be exactly upon the inner edge of the halo, while γ Geminorum was within the ring at a distance from it, which, as nearly as I could judge, was a quarter of the moon's diameter. From these data I find that the radii of the halo measured from the centroid of the illuminated disk of the moon through these two stars were 22.8° and 21.4°, respectively. Assuming that the halo was elliptical with the major axis vertical, I deduce values of 23.3° and 21.4° for the semi-major and semiminor axes. I am aware that a more or less complete halo, the major axis of which is horizontal, is occasionally seen surrounding the 22°-halo, but records of halos elongated vertically are rare. In 1908 Prof. Schlesinger noticed one, the axes of which were about 7° and 4°.

Sir Napier Shaw informs me that very little is done in this country on the shapes of halos, so that this letter may serve to direct attention to the desirability of obtaining accurate measurements.

REAL VELOCITIES OF METEORS.[3]

By CHARLES P. OLIVIER.

[*Reprinted from* Science Abstracts, Sect. A, Jan. 31, 1918, § 29.]

From a list of real flights of meteors observed by members of the British Astronomical Association (B. A. A. Journal, January, 1917), eight doubly-observed meteors are selected as assigned to a radiant near R. A. = 302°, Decl. −8°. This position is not far from the ecliptic, and appears to be a very likely example of a stationary radiant. To investigate the orbits reductions were made by Bauschinger's method, and the results are presented in a table showing the elements for each meteor orbit. Some difficulty is introduced by the importance of the duration of the time of flight, the observation of which is scarcely accurate enough when made visually, and it is hoped that systematic work may soon be done with photographic registration, apparatus having been designed for this purpose by the late Cleveland Abbe. It is concluded that the radiant under discussion is the most promising of all those hitherto examined with regard to its likelihood of being a stationary radiant.—*C. P. B[utler]*.

VISIBLE WEATHER [CHINOOK WEATHER ¡ !].

The following interesting communication, by Robert T. Pound, is reprinted from Scientific American, New York, February 16, 1918, page 147:

LAVINA, FERGUS COUNTY, MONT.
[Lat. 46° 12′ N., long. 109° W.]

On December 14 [1917], after several days of storm, my brother and I noticed that the western end of the Big Snowy Mountains, about 20 miles northwest of our place, seemed strangely distorted, the distor-

[1] Publication approved by Division of Aërological Investigations.

[2] The 46°-halo or its upper arc is not so very rare in this country. The REVIEW for July, 1914, pp. 431-436, presents in its figures 1, 3, 5, and 8, illustrations of 46°-halo seen in November, 1913; cases of the 46°-halo are also reported in the REVIEW for October, 1917, p. 486, and for May, 1915, p. 215.—C. A., jr.

[3] The Observatory, October, 1917, No. 518, p. 365-368.

tion extending about halfway up the mountain. On closer examination we noticed that this distortion was moving from west to east at a tremendous rate, still keeping the same height as when first observed. Because of the similarity of the waves in this effect to the heat waves sometimes seen on a hot summer day, we at once concluded that this was a chinook [sic]. The temperature when we first observed the chinook, at 10:30 o'clock, was 4° F.; the succeeding temperatures were as follows:

	°		°
10:33 a. m.	7	12:30 p. m.	26
10:50 a. m.	9	1 p. m.	30
11:05 a. m.	12	2 p. m.	34
11:35 a. m.	19	8 p. m.	33
Noon	22		

While this temperature rise is not as phenomenal as a drop of 40° in 30 minutes, which I observed on February 3, 1917, still it is of vastly more benefit to the stockman. Chinooks which occur here are invariably accompanied by a high wind from the west or northwest. Inasmuch as the generally accepted theory is that these winds come directly from the Pacific Ocean, it would be interesting to learn why only two or three chinooks, at the most, occur during a season in which 90 per cent of the winds are high and from the two above-named directions.

[The date given in this communication was one on which a chinook was blowing over the Big Snowy. There was a sharp rise in temperature amounting to as much as 40° at Havre, Mont., on the morning of December 15. From the observer's position at Lavina the Big Snowy Mountains lie directly northwest and about 20 miles distant, as he states, but without a more precise description of the nature of the distortion in the image of the mountains it is difficult to say whether the warm, dry air of the chinook actually caused it or not. Similar observations in connection with a chinook or a foehn have not come to the bureau's attention.

The present phenomenon accompanied what was undoubtedly a case of the "dry" chinook wind, a wind which is not at all related genetically to the Pacific Ocean, but derives its warm, dry nature from the forced rapid descent along the topography under the compulsion of the existing pressure distribution. See this REVIEW, April, 1907, **35**:176, column 2.]

WEATHER BUREAU OBSERVATIONS IN CONNECTION WITH THE SOLAR TOTAL ECLIPSE OF JUNE 8, 1918.

By H. H. KIMBALL and S. P. FERGUSSON.

[Weather Bureau, Washington, D. C., June 19, 1918.]

The Weather Bureau observational campaign related to the solar eclipse of June 8, 1918, was planned by the authors jointly. The studies in radiation were particularly planned and executed by Prof. Kimball; while the general meteorological observations were planned and instructions prepared by Mr. Fergusson.

Radiation observations.—The Weather Bureau observations of radiation were made by Prof. Kimball at the special station established at Goldendale, Wash. (lat. 45° 50′ N.; long. 120° 48′ W.; alt., 1,650 feet[1]). There he installed a Smithsonian pyranometer for measuring the intensity of both the direct solar radiation and the diffuse sky radiation; and also a pyrgeometer of the Ångström type, for measuring the intensity of the outgoing radiation at night and also during totality. Observations with the pyranometer were commenced June 4, 2 p. m., 105th meridian time, and continued at frequent intervals each day until 8 p. m. of June 8. Observations with the pyrgeometer were made each night from June 4–5 to June 9–10; those on the night of June 4–5 continued at frequent intervals from 8 p. m. to 4 a. m., on other nights they were generally made between 8 and 11 p. m. The pyranometer was also employed in measuring outgoing radiation.

Near the radiation apparatus was installed an instrument shelter screening a thermograph, hygrograph, maximum and minimum thermometers. Continuous records of temperature and humidity were obtained from June 4, noon, to June 10, 10 a. m.; and were supplemented by eye readings of an Assmann ventilated and of a sling psychrometer at hourly intervals from 9 a. m. to 6 p. m. each day.

At the same hours a record was made of direction and force of the wind, and the kind, amount, and direction of clouds.

On June 8, for an hour preceding and following the total phase of the eclipse, the wind, cloud, and psychrometer observations were made at 10-minute intervals.

During totality excellent measurements were obtained of the intensity of outgoing radiation.

Meteorological observations.—The program of meteorological observations was based chiefly on certain results of studies by Clayton, Bigelow, and others of the eclipses of May 28, 1900, and August 30, 1905. The field work was limited to observations of atmospheric pressure and temperature, direction of wind, clouds, and shadow-bands. On the day of the eclipse special observations of pressure, temperature, wind, and clouds were made every half hour, beginning at noon and ending with the last regular telegraphic observation of the day. From an hour before until an hour after totality, however, the observations were made every 10 minutes. In order to allow for local changes of any kind, additional observations of wind direction were made at corresponding hours daily from June 3 to 15, inclusive. Pressure observations were careful eye-readings of a mercurial barometer, and wind observations were of a vane reflected in the mirror of a nephoscope, thereby permitting determination of direction to less than 5° of arc.

These observations were made at about 55 stations, nearly all located west of the Mississippi and within the zone of 90 per cent obscuration. Pressure was observed at 45 stations; temperature at 15; clouds at 36; and wind direction at 17.

Continuous records of temperature, pressure, and wind velocity are, of course, available from a number of regular stations of the Weather Bureau within and near the path of totality. Special instructions for observing shadow-bands were sent to many regular and cooperative observers suitably located.

The reports of these special meteorological observations are now coming in rapidly and indicate generally that partly cloudy or cloudy weather prevailed throughout and near the path of totality as far eastward as special observations were made. Probably this condition of the sky seriously interfered with observations of shadow-bands.

[1] Based on local railroad determination.

SECTION II.—GENERAL METEOROLOGY.

SOLAR DISTURBANCES AND TERRESTRIAL WEATHER.

By Ellsworth Huntington, Research Associate in Geography.

[Dated: Yale University, New Haven, Conn., Mar. 7, 1918.]

(*Continued from* this Review, March, 1918, p. 141.)

II. Sunspots Compared With Changes in the Weather.

Solar quadrant differences compared with changes of barometric gradients for all days during 1904–1913.

The first article of this series led the writer to the conclusion that storminess in the North Atlantic Ocean is closely associated with differences in the amount of spottedness upon different portions of the sun's surface. It appeared that during the years 1904–1909 pronounced barometric disturbances occurred when the spottedness of the marginal portions of one pair of diametrically united solar quadrants greatly exceeded the spottedness in the other pair of quadrants. One of the best tests of this conclusion is to reverse the order of procedure. Instead of proceeding from the earth to the sun, let us start with the supposed solar cause and compare it with the supposed result. For the sake of varying our terrestrial data we may this time use neither the absolute strength of the barometric gradients, nor their increase or decrease, but their change from day to day, no matter in which direction. Judging from figures 5 and 6 (pp. 129,130) this method will perhaps not give such striking results as if increase of gradients were used for the northern part of the North Atlantic and decrease for the southern. On the other hand, by using the change in gradients we employ perhaps the best of all means of measuring the total variability of the weather. For the solar data we use the quadrant differences as already defined—that is, the difference between the sum of [A+D] (fig. 3) and the sum of [B+C] without regard to which of the two sums is larger.

Let us first divide all the days of the 6-year period 1904–1909 into groups on the basis of the quadrant differences in the sun. As appears in Table 6, group A consists of 653 days having a quadrant difference of 10 or less, group B of 284 days with a difference of 11 to 20, and so up to group H, consisting of 156 days, with a difference of over 150. If these solar differences are really responsible for changes in the weather, we should expect the daily change in gradients to increase from group A to group H. The extent to which this is the case is shown in figure 9. Here the height of the curves above the zero line at the bottom indicates the degree of variability of the weather. The distance from left to right indicates the solar activity in terms of the difference between the sunspot areas in the marginal portions of the two pairs of diametrically united quadrants. If our hypothesis is right the curves ought to rise from left to right.

In figure 9 the upper dash lines represent the barometric variability of the southern section of the North Atlantic. Below these come solid lines representing the average for both sections of the Atlantic, and dotted

Table 6.—*Changes in barometric gradients of all days, March, 1904, to December, 1909, compared with solar quadrant differences (see fig. 9).*

[N=Sum of changes of gradient in northern section of North Atlantic; S=Sum of changes of gradient in southern section of North Atlantic.]

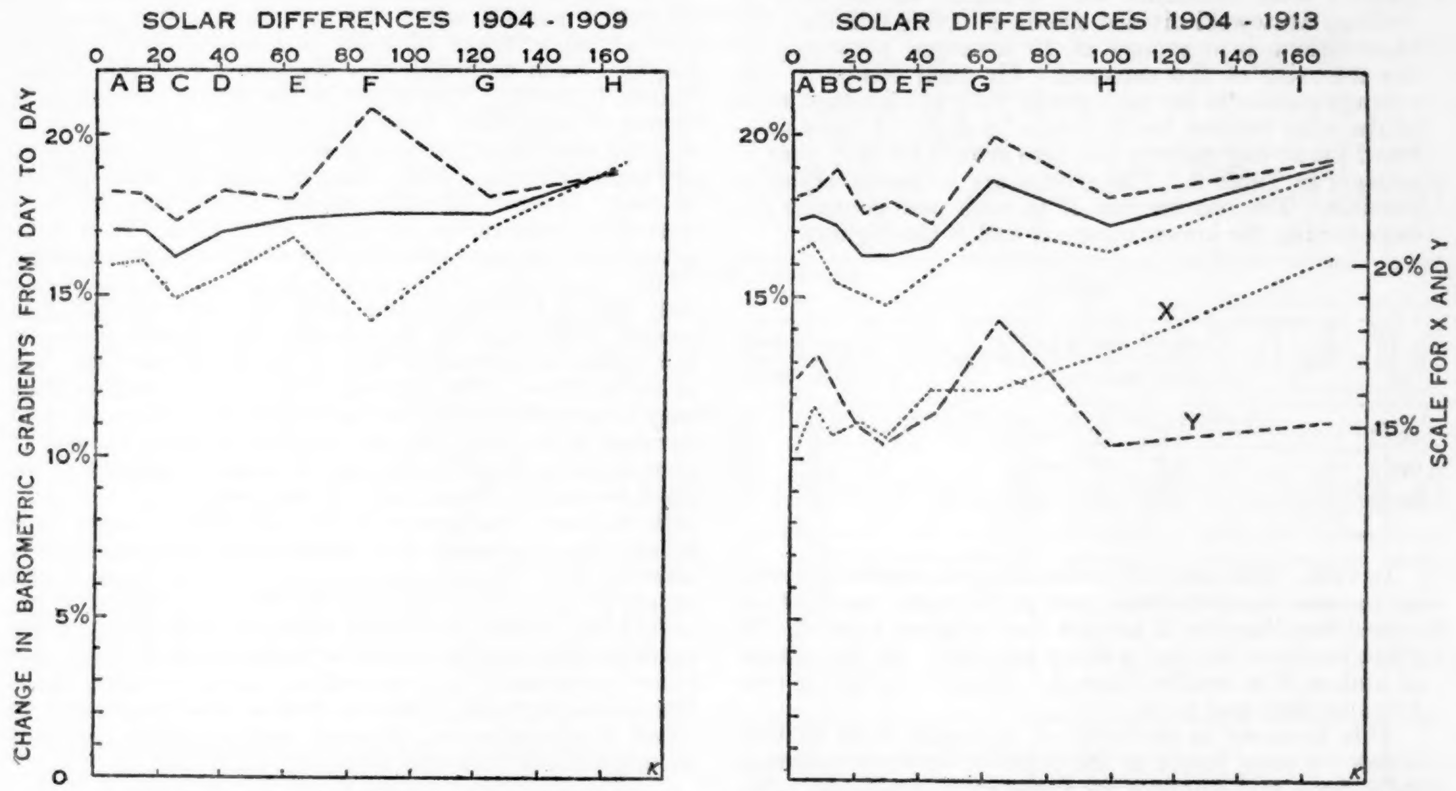
Quadrant difference.	A, 0-10.			B, 11-20.			C, 21-30.			D, 31-50.			E, 51-75.			F, 76-100.			G, 101-150.			H, over 150.		
Year.	Days.	N.	S.	Days.	N.	S.	Days.	N.	S.	Days.	N.	S.	Days.	N.	S.	Days.	N.	S.	Days.	N.	S.	Days.	N.	S.
1904	111	1,630	2,186	65	1,074	1,067	31	365	563	39	462	612	28	440	530	16	173	288	10	213	197	6	117	70
1905	82	1,275	1,288	36	524	754	35	545	577	49	748	882	49	841	963	32	518	819	37	632	635	44	888	900
1906	122	1,877	2,449	39	601	698	33	541	594	54	861	964	50	726	825	29	560	508	26	525	455	12	167	171
1907	80	1,366	1,550	51	819	853	36	587	600	35	572	572	54	954	937	27	318	590	29	491	410	53	1,183	1,171
1908	126	2,096	2,300	50	894	818	33	477	541	59	943	1,200	43	774	768	22	313	288	18	303	308	15	192	190
1909	132	2,136	2,065	43	643	925	38	573	609	37	633	761	34	612	612	30	337	782	25	300	598	26	411	427
Total	653	10,380	11,838	284	4,555	5,115	206	3,088	3,574	273	4,219	4,991	258	4,347	4,635	156	2,219	3,255	145	2,464	2,603	156	2,958	2,929
Average	......	15.9	18.2	......	16.0	18.1	......	14.9	17.3	......	15.5	18.3	......	16.8	18.0	......	14.2	20.8	......	17.0	18.0	......	18.9	18.8

Table 7.—*Changes in barometric gradients of all days, March, 1904, to December, 1913, compared with average solar quadrant differences for the period of four days ending with the day of the observed change of gradient (see fig. 9).*

[N=for northern section of North Atlantic Ocean; S=for southern section of North Atlantic Ocean.]

Quadrant difference.	A, 0-5.			B, 6-10.			C, 11-17.			D, 18-25.			E, 26-37.			F, 38-50.			G, 51-75.			H, 76-125.			I, over 125.		
Year.	Days.	N.	S.	Days.	N.	S.	Days.	N.	S.	Days.	N.	S.	Days.	N.	S.	Days.	N.	S.	Days.	N.	S.	Days.	N.	S.	Days.	N.	S.
1904	43	607	709	36	525	671	50	776	971	52	851	750	45	653	897	28	355	518	30	411	609	17	266	251	5	134	136
1905	11	128	135	17	228	296	22	294	479	37	512	630	53	985	943	50	802	863	56	935	1,263	62	1,020	1,152	56	997	1,121
1906	39	502	809	25	388	531	48	783	1,119	32	486	526	61	786	1,059	44	729	759	61	1,093	1,087	46	918	767	8	112	136
1907	11	250	139	23	431	459	33	404	506	27	380	458	51	853	836	36	660	567	68	1,029	1,506	60	995	1,105	57	1,307	1,153
1908	39	671	732	35	625	666	54	905	1,005	33	409	577	62	1,019	1,083	38	521	682	69	1,475	1,170	21	305	328	15	199	126
1909	35	581	534	36	587	551	43	749	790	43	586	713	51	647	1,101	36	639	626	52	861	1,182	39	555	878	30	479	532
1910	129	2,092	2,393	34	582	729	36	637	491	47	734	1,039	43	524	776	27	450	474	32	534	588	14	192	193	5	58	90
1911-1913	898	14,894	16,311	73	1,264	1,201	50	631	1,007	27	499	515	31	532	564	9	76	152	6	44	73	1	16	18	0	0	0
Total for 1904-1913	1,205	19,725	21,762	279	4,630	5,104	336	5,179	6,368	298	4,458	5,208	407	5,999	7,250	268	4,232	4,641	374	6,382	7,478	260	4,267	4,692	171	3,228	3,294
Average for 1904-1913	......	16.4	18.1	......	16.6	18.3	......	15.4	19.0	......	15.0	17.5	......	14.7	17.9	......	15.8	17.3	......	17.1	20.0	......	16.4	18.0	......	18.9	19.2

lines for the northern section. According to these lines barometric variability appears to be greater in the southern section of the North Atlantic than in the northern. As already explained, however, this is merely because the figures for gradients have been reduced to percentages. In the left-hand part of figure 9 one of the first features to attract the eye is the marked rise of one curve and fall of the other between 80 and 100. This means that during the group of days marked F there happened to be an unusual number of storms with courses more southerly than the normal. They caused unusually great changes in the weather in the southern section of the North Atlantic where high pressure generally prevails, while the northern section was unusually free from such changes. This is significant because it indicates that if it were possible rigidly to separate areas of high and low pressure our solar relationships would appear more distinct than is now the case.



. . ., changes in gradients in north section of North Atlantic Ocean, 1904–1909.
— — —, changes in gradients in south section of North Atlantic Ocean, 1904–1909.
——, average of . . . and — — —

X, changes in northern section, 1904–1907, when sunspots were abundant or increasing.
Y, changes in northern section, 1908–1913, when sunspots were scarce or decreasing.

FIG. 9.—Changes in barometric gradients from one day to the next, in relation to days having varying differences between the areas of the umbræ in the NW.+SE. quarters of the sun's visible disk, at a distance of more than 30° from the central meridian and in the NE.+SW. quarters.

Taking the lines in the left-hand part of figure 9 separately and disregarding the minor fluctuations, we see that aside from the point *F* the dash line representing the variability of the weather in the southern section has a slight tendency to rise from left to right. The average change of gradients from day to day in groups A to D is 18 per cent while in groups E to H it is 18.9 per cent. In the northern section, as appears in the dotted line, the rise from left to right is greater, being from 15.6 in groups A to D to 16.7 in groups E to H. Except for an accidental depression in group C, the combined line for the two sections rises rather steadily from 17 at the left end (group A) to 18.9 on the right (group H). Thus there is evidence that the greater the solar difference the greater the variability of the weather in the North Atlantic Ocean. This is especially true in the northern section, for there the variability in group A is only 15.9 while in group H it is 18.9, a difference of 19 per cent.

If instead of group H, which includes 156 days having quadrant differences of over 150, we take a smaller group of 87 days with quadrant differences of over 200, the average variability from day to day in the northern section of the North Atlantic rises from 18.9 to 19.1. This is 18 per cent above the general average, which is 16.2, and 20 per cent above group A. Among the 87 days of the group with largest quadrant differences, 43 show an increase in gradients, averaging 18.8, while 44 show a decrease averaging 19.4.

If a difference in the solar quadrants for only a single day produces a terrestrial effect, a continuance of such a difference would presumably produce a greater effect. Therefore in Table 7 and in the right-hand part of figure 9 all the days from 1904 to 1913 are classified into 9 groups according to the average difference in the solar quadrants during the period of 4 days ending with the day in question. In group A this average quadrant difference is 5 or less, in group B, 6 to 10, and so on up to group I where the average differences are over 125. In spite of considerable irregularity the three upper lines in the right-hand part of figure 9 show a stronger upward tendency from left to right than do the corresponding lines in the left-hand part of the diagram. Years of many and few sunspots, however, by no means act alike. This is evident from lines *X* and *Y* in figure 9. Line *X* pertains to the years 1904–1907 when sunspots were *increasing*. Line *Y* pertains to 1908–1913 when sunspots were *decreasing*.

The zero point of X and Y, it will be noted, has been placed lower than that of the other lines in order to avoid overlapping. Curve X has a pronounced upward tendency. The right-hand end is more than 30 per cent higher than the left, and the irregularities are small. Curve Y on the other hand, scarcely shows any distinct tendency either upward or downward. The average of groups A to E, to be sure, is 15.22, while that of F to I is 15.75. Nevertheless, here, just as in a previous case, we are confronted by what seems to be a contradiction; in general the greater the solar differences the greater the barometric disturbances, but when the sun's surface becomes unusually quiet this generalization breaks down.

This apparent anomaly is similar to one found by Arctowski[1] in studying the relation of the solar constant to the number of sunspots. For all the years for which Abbot's solar constants were available at the time of writing, Arctowski divided the days having reliable solar observations into groups of 10 arranged according to the intensity of the constant. He then compared the average constants for each group with the average areas of the solar umbræ for the same 10 days. I have combined his 10-day periods into two groups for each year as appears in Table 8. The groups are as nearly equal as possible. The one marked A in each case contains the days having the lowest constant and B the highest.

TABLE 8.

Year.	Solar constant.	Area of umbræ.	Year.	Solar constant.	Area of umbræ.
1905 A	1.99	212	1909 A	1.88	96
1905 B	2.06	246	1909 B	1.95	59
1906 A	1.99	133	1910 A	1.89	64
1906 B	2.04	207	1910 B	1.94	52
1907 A	1.92	122	1911 A	1.90	7
1907 B	1.96	170	1911 B	1.95	5

In 1905, 1906, and 1908, when sunspots were numerous, an increase in spottedness and in the solar constant occurred together, for B in each case is larger than A. In 1909, however, we find a sharp reversal. In the column of umbræ B is smaller than A. Similar conditions continue in 1910 and 1911.

This anomaly is probably of the same kind as that which we have found in the relation between quadrant differences and changes in barometric gradients. Apparently sunspots are not in themselves the cause either of an increase in the sun's thermal radiation, or of a change in the barometric conditions of the earth. All three are apparently merely the results of some other cause. Suppose for the moment that the primary cause of variations (1) in the solar constant, (2) in the area of sunspots, and (3) in terrestrial storms is the eruption of intensely heated gases or vapors from the lower part of the sun's atmosphere. This, we will suppose, is followed by the formation of vaporous clouds which at first appear as bright faculæ, but later become relatively cool and dark, and are sucked downward in the vortices known as sunspots. We will assume further that at such times the solar constant varies in harmony with the area of the sunspots, and the disturbances of terrestrial weather show a similar variation. Suppose, however, that the circulation of solar vapors is relatively mild. It might easily happen that the clouds of vapor would be so thin that we could not detect them, and that the downward movements would not be sufficiently concentrated to form visible dark spots. Yet the observed changes in the solar constant and in the weather might go on. Thus variations in both the solar constant and the weather may be closely associated with sunspots when the sun's surface is highly active, but may also arise from the same causes even when there are no visible signs of such activity.

[1] *Arctowski, H.* Sur les fluctuations de la constant solaire. Comptes rendus, Paris, 163: 665

Comparison of extreme solar disturbances with North Atlantic gradients.

From this brief excursion into the realm of theory let us turn back to actual facts of observation. Let us test various methods in order to see how far the method of quadrant differences is justified. We will inquire first what happens on the earth for 8 days before and 8 days after the periods when the quadrant differences and several other types of solar phenomena are at their height. Such an inquiry is illustrated in Table 9 and figures 10 to 14. The height of the curves indicates the degree of variability from day to day. The time when a given condition prevails is shown by the numbers at the top or bottom. The "days of solar disturbance" are of many types. All alike include all the days of their particular type in the 10 years, 1904–1913. It so happens, however, that owing to the small sunspot numbers of the years 1911–1913, no days from 1911 and 1913 and only one or two from 1912 enter into any of these diagrams. The days of disturbance may occur singly, or more often in periods of two, three, or in rare cases, six or seven days. The interval between two such periods may be anywhere from one day upward. Only about 30 per cent of the time does the interval between the end of one period and the beginning of another amount to 16 days or more. Hence only in this proportion is it possible to carry the figures to the full limit of eight days before the beginning of a disturbance and eight days after the end without repeating one or more days. Such repetition not only would give the days in question undue weight, but would cause days which are influenced by the specified solar conditions to be reckoned as if they came before such conditions, as well as during or after them. Hence in preparing Table 9 it has been necessary to adopt a somewhat complicated method which can best be understood from the following example:

Example illustrating method of preparing Table 9.

Date.	Days before.								Days of solar disturbance.								Days after.							
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
1905.																								
June 28	45	21	44	4	3	9	7	1	30	2	40	..	..	..	..	..	4	29	17	2	10	..	..	..
July 10	..	..	..	..	16	2	11	4	20	27	8	2	15	21	33	..	15	8	..	..	..	..	..	..
July 19	..	..	..	..	..	..	..	..	43	4	59	33	45	..	..	..	1	8	12	11	14	0	24	3

June 28, 1905, was the first day of a quadrant difference of over 100. The change in the gradient index in the northern section of the North Atlantic from June 27 to June 28 amounted to 30 per cent of the normal gradient for that date. Hence the number 30 is recorded opposite June 28 under the first "day of solar disturbance." The next two days were also marked by quandrant differences of over 100. Hence their changes of gradients, 2 per cent and 40 per cent, are recorded under the second and third days of solar disturbance.

Previous to June 28 there were no strong quadrant differences for some time. Hence it is possible to record the "days before" to the full number of 8. The first "day after" the end of the solar disturbance was July 1, with a change in gradients of 4 per cent. Beginning with this day we have a series of 9 days falling between the end of one solar disturbance and the beginning of another. These are divided so that 5 fall among the "days after" and 4 among the "days before." With July 10 we enter upon a disturbed period of unusual length.[2] Between the end of this disturbance and the beginning of that of July 19 only two days intervene. These days are presumably influenced by the conditions

The net result of this method is that we have in the center a group of days which are unmistakably under the influence of strong solar disturbances. On either side we have days which are not so much under that influence. They are by no means free from it, however, for disturbances do not begin and end suddenly. Moreover, at intervals of 10 or more days before and after the beginning of solar disturbances, as has already been explained, there are almost sure to be other disturbances due to the fact that the disturbing groups of sunspots reach an effective position first on the sun's eastern margin and then on the western. Hence, even if quadrant differences were the only cause of baro-

TABLE 9.—*Changes in barometric gradients in relation to solar differences, 1904–1913.*

[N=northern section of North Atlantic. S=southern section of North Atlantic.]

A. IN RELATION TO 138 PERIODS WHEN THE QUADRANT DIFFERENCE EXCEEDS 100. (See Fig. 10.)

	Days before.								Days of solar disturbance.								Days after.							
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Number of days	39	47	49	55	63	67	74	90	138	82	58	34	11	2	1	0	138	120	107	101	61	54	50	44
Average change of gradients N	18.4	18.3	17.5	14.2	15.4	15.2	16.3	14.0	16.5	16.2	21.6	19.1	18.8	14.5	33.0	......	17.3	15.3	16.1	17.2	14.1	14.5	16.9	15.2
Average change of gradients S	17.1	19.3	18.8	19.6	19.1	19.3	17.4	19.2	17.5	17.9	20.3	19.8	11.1	24.0	44.0	......	19.8	17.0	18.5	19.5	20.6	17.5	17.9	16.1

B. IN RELATION TO 144 PERIODS WHEN THE DIFFERENCE BETWEEN THE UMBRAL AREA ON THE EAST SIDE OF THE SUN WITHIN 60° OF THE MARGIN AND ON THE WEST SIDE WITHIN 60° OF THE MARGIN, EXCEEDS 100.

	Days before.								Days of solar disturbance.								Days after.							
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Number of days	35	38	44	51	59	62	69	90	144	96	63	43	14	3	2	1	144	125	114	102	55	49	42	36
Average change of gradients N	17.2	15.4	15.8	14.7	16.6	14.5	14.5	15.2	16.9	15.0	20.4	16.1	20.1	18.7	15.0	24.0	16.6	16.2	16.2	14.8	16.2	14.6	17.9	17.3
Average change of gradients S	17.4	17.0	20.6	20.7	18.9	20.0	17.8	18.9	17.9	19.1	19.8	22.6	9.9	7.7	16.0	16.0	17.1	17.1	19.8	18.6	16.9	18.2	18.2	14.4

C. IN RELATION TO 110 PERIODS WHEN THE UMBRAL AREA WITHIN 30° OF THE SUN'S CENTRAL MERIDIAN EXCEEDS 100. (See Fig. 13.)

	Days before.								Days of solar disturbance.								Days after.							
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Number of days	40	48	52	56	66	71	78	81	110	82	64	53	30	8	5	5	110	98	90	86	64	54	50	45
Average change of gradients N	15.4	15.6	15.9	16.5	16.3	17.2	15.2	16.2	16.5	16.4	16.8	16.2	13.9	12.1	8.6	6.6	15.8	14.5	19.7	15.7	17.0	19.2	16.0	15.8
Average change of gradients S	20.3	15.3	21.6	22.3	18.3	20.8	20.6	19.6	19.0	14.4	18.9	15.9	13.3	10.3	15.4	14.4	16.6	18.0	18.5	18.5	18.1	19.9	20.0	22.0

D. IN RELATION TO 53 PERIODS HAVING AN UMBRAL DIFFERENCE OF OVER 100 BETWEEN THE AREAS NORTH AND SOUTH OF THE SUN'S EQUATOR AND WITHIN 60° OF THE SUN'S MARGIN, BUT HAVING A QUADRANT DIFFERENCE OF LESS THAN 100.

	Days before.								Days of solar disturbance.								Days after.							
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Number of days	34	35	36	38	42	44	47	48	53	19	10	6	......	......	......	......	53	51	51	50	41	37	35	34
Average change of gradients N	16.9	18.1	14.6	15.1	19.2	14.4	17.1	14.5	15.4	12.3	14.5	16.0	......	......	......	......	17.3	16.7	19.9	15.5	16.4	18.1	16.3	14.6

E. IN RELATION TO 79 PERIODS HAVING AN UMBRAL AREA OF OVER 100 IN THE COMBINED EAST AND WEST SECTIONS OF THE SUN WITHIN 60° OF THE MARGIN, BUT HAVING A QUADRANT DIFFERENCE NOT EXCEEDING 50.

	Days before.								Days of solar disturbance.								Days after.							
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Number of days	28	31	31	34	39	46	48	56	79	24	10	2	......	......	......	......	79	67	66	60	38	32	31	31
Average change of gradients N	12.9	16.9	16.7	17.8	21.5	14.7	16.2	14.6	16.5	16.7	20.5	17.5	......	......	......	......	15.8	13.4	16.3	18.6	17.1	18.5	19.0	15.7

F. IN RELATION TO 159 PERIODS WHEN THE DIFFERENCE BETWEEN THE UMBRAL AREAS WITHIN 60° OF THE SUN'S MARGIN IN THE NORTHERN HEMISPHERE PLUS THE DIFFERENCE BETWEEN SIMILAR AREAS IN THE SOUTHERN HEMISPHERE, AMOUNTS TO 100 OR MORE.

	Days before.								Days of solar disturbance.								Days after.							
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Number of days	36	40	46	51	61	69	76	94	159	108	82	56	24	8	4	1	159	138	125	114	57	48	43	37
Average change of gradients N	17.1	14.2	14.4	16.0	17.0	15.4	14.2	13.9	16.4	15.9	18.6	16.4	18.8				16.4	15.7	17.4	16.9	14.7	13.5	18.7	13.8

of the preceding period of solar disturbance. They can scarcely be influenced by the solar disturbance that comes after them. Hence they are reckoned as the first and second days after a disturbance, and all the days before the disturbance of July 19 are left blank. The same method is followed whenever the number of days between the disturbances is 4 or less. If the number is from 5 to 8, however, the days beyond 4 are reckoned as preceding the second solar disturbance.

[2] Such periods are so rare that in plotting the results of this tabulation in lines *A* to *C*, figs. 10 and 14, all days from the sixth onward are reckoned with the fifth, while in lines *D* and *E* of fig. 10 all from the fourth onward are reckoned with the third. In fig. 11 the sixth, seventh, and eighth are reckoned as a separate group, while in fig. 13 all from the fifth to the eighth are reckoned with the fourth.

metric differences, we should not expect barometric variability to fall to a low ebb during the days before and after the times of solar disturbances.

There are other and stronger reasons why the barometric variability does not fall to a low ebb at times when quadrant differences in the sun are small. One of these is the fact that when a barometric disturbance has once arisen, no matter what the cause, it often persists many days and travels long distances. Thus a disturbance which arises thousands of miles away may be felt in the Atlantic Ocean one or two weeks later. Another important consideration is that variations in the sun's heat, as measured by the solar constant, also

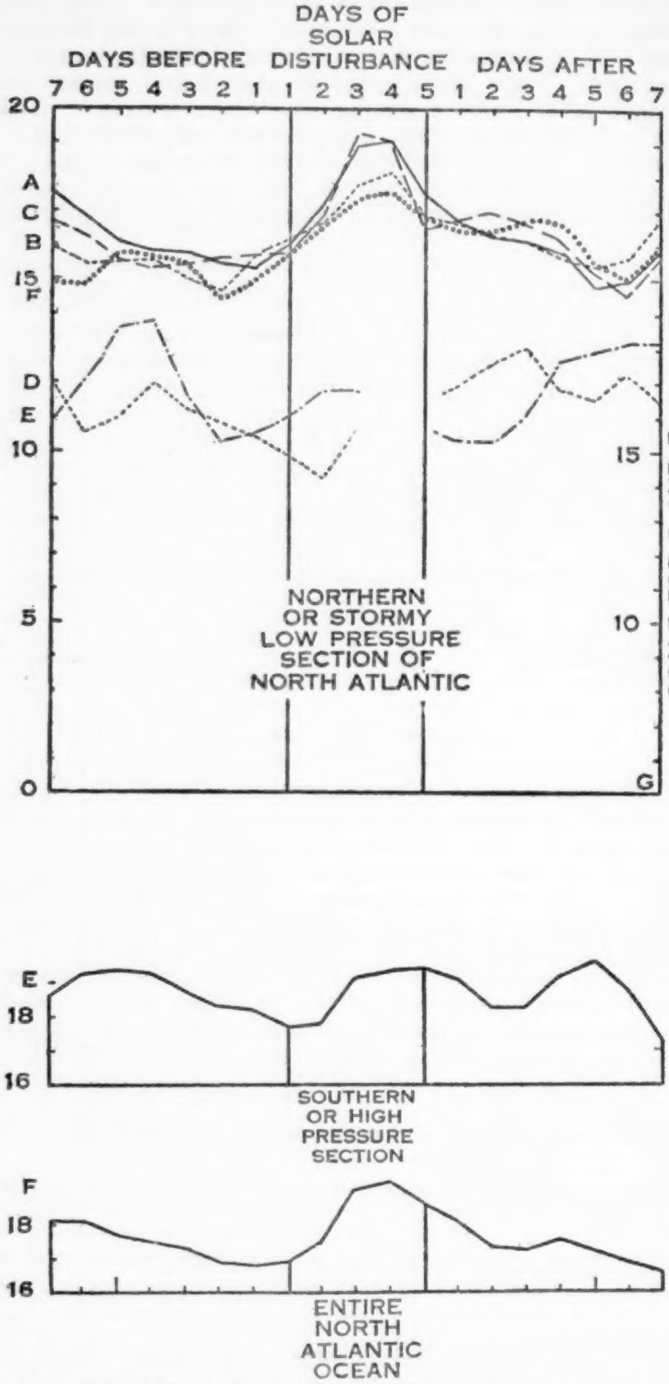
appear to influence barometric gradients. Such variations in the solar constant, however, occur on an important scale at times when there are no visible quadrant differences. Again, we are by no means sure that the quadrant differences give a full measure of the solar activity which causes barometric disturbances. As has already been indicated, the activity of sunspots is probably merely one of the more striking results of solar changes which give rise to a variety of phenomena. Among these phenomena may be included not only the solar constant, but faculæ, prominences, and magnetic variations. Most important of all, we should not expect barometric variability to fall to an extremely low ebb at times of low quadrant differences because the sun is continually changing its altitude. Even if the sun's radiation were absolutely constant, barometric variations would still occur because the angle at which the sun's rays reach the earth varies not only from hour to hour, but from season to season, and from place to place. Hence the distribution of heat upon the earth's surface constantly varies, and there must be corresponding changes in atmospheric pressure. Thus it appears that in our study of quadrant differences we are not dealing with the entire cause of variations in atmospheric pressure, but with *a hitherto unrecognized cause which appears to be superposed upon the other causes. When it is unusually strong it may temporarily outweigh the others, but when it is weak they reassert their supremacy.*

We have now reached the most critical part of our investigation. We must compare the barometric variability represented by line *A* in figure 10 with the variability represented by the other lines in figures 10 to 14. In order to facilitate comparison all the lines have been smoothed by the formula $\frac{1}{4}(a+2b+c)=b$. This, however, does not alter the main outlines, as may be seen from the original figures in Tables 9 and 10.

Line *A* in the upper part of figure 10 is based on the first part of section A of Table 9. It includes all days (138) having a quadrant difference, or solar disturbance as we may say for convenience, of over one hundred millionths of the sun's visible surface according to the Greenwich tables. In other words, when the difference between $A+D$ and $B+C$ in figure 3 [p. 125] exceeds 100, the day is included. Line *A* indicates that for 4 or 5 days before the beginning of a period of pronounced quadrant differences the change in barometric gradients in the stormy northern section of the North Atlantic Ocean is slight. As soon as the quadrant differences become pronounced, however, the variability of the weather increases rapidly, as appears from the upward slope of *A*. The variability reaches a maximum on the third or fourth day of the solar activity. This maximum is about 24 per cent greater than the minimum variability before the solar activity begins, and 29 per cent greater than the minimum on the fifth day after the end of the solar activity.

The two diagrams at the bottom of figure 10 show the the variability of the weather in the southern section of the North Atlantic and in the two sections combined. The line for the southern section is inconclusive. It rises, to be sure, at times of great quadrant differences, but it rises equally high in the periods before and after. The line for the two sections combined—that is, for the entire North Atlantic Ocean—scarcely needs comment. It shows an unmistakable maximum at times of great solar differences. For our present purposes the northern section is clearly the place of chief importance.

Let us see whether other methods of computing the solar conditions give results as striking as those already obtained. Instead of computing the solar activity by the method of differences between the outer parts of diametrically united pairs of quadrants (quadrant differences), would it be equally effective to take the periods



A, average daily change in gradient in relation to 138 periods when the area of the solar umbræ in the NW.+SE. quadrants of the sun's visible disk at a distance of over 30° from its central meridian differs from that of the similar umbræ in the NE.+SW. quadrants by 100 millionths or more of the sun's surface.

B, the same for 144 periods when umbræ on the east at a distance of over 30° from the central meridian differ from those on the west by 100 millionths or more of the sun's surface.

C, the same for 80 days which fall in both group *A* and group *B*, as described above.

FIG. 10.—Changes in barometric gradients over the North Atlantic, from day to day, in relation to solar activity.

when the difference between the marginal areas on the east and west sides of the sun (marginal differences) exceeds 100; that is, when the difference between $A+C$ and $B+D$ in figure 3 exceeds 100? This has been done

in section B of Table 9, and in the dotted line *B* in figure 10. The method of tabulation is identical with the one described above. The number of periods of solar disturbance is essentially the same, namely, 144 instead of 138. The resultant curve is also similar, but there is an important difference. The contrast between the highest and lowest points is less than for the solid line. Where the vertical distances from the two minima to the central maximum amount to 24 and 29 per cent for the solid line *A*, they amount only to 23 and 18 per cent for *B*.[3] In fact it seems safe to conclude that the dotted line rises in the center largely because it is based in part on periods which have a quadrant difference of over 100 and hence are used in computing line *A* as well as line *B*. There are 80 such periods common to both the solid and the dotted lines. When computed by themselves, they give the dash line *C*. This is essentially the same as the solid line except that the minima differ from the maximum by 26 and 32 per cent instead of 24 and 29. Therefore the difference between *A* and *B* must be due to the 64 periods which have a *marginal* difference of 100 or more, but do not have a marked *quadrant* difference. That this is the case appears from line *B*, figure 11. In preparing this line use has been made of 34 periods which occur among the 64 mentioned above, but do not come within two days of periods having quadrant differences of 100 or more, and hence have small quadrant differences. The central dip of the line for these 34 periods suggests that when there is little or no quadrant difference, a marginal difference between the opposite sides of the sun's disk does not have a marked effect upon the barometric gradients of the northern section of the North Atlantic Ocean.

Let us see whether contrasts between the spottedness of the outer 60° of the sun's northern and southern hemispheres is any more important than a contrast between the east and west margins. This matter is tested in section D of Table 9. This is based on 53 periods which have a difference of 100 or more between the north and the south; that is between $A+B$ and $C+D$, figure 3, but have quadrant differences of less than 100. In other words, these periods had a strong difference between north and south, but not between the marginal portions of the diametrically paired quadrants, $A+D$ and $B+C$, figure 3. The way in which they were related to barometric changes is shown in line *D*, figure 10. The zero for this line, as well as for line *E*, has been lowered to prevent crowding. Line *D* is low during the critical period of solar disturbance, but rises fairly high immediately afterward. This suggests that a difference between the spottedness on the two sides of the sun's equator may possibly have some effect on the earth's atmosphere, but that, like marginal differences, it is not nearly so important as quadrant differences.

As still another means of testing our conclusions let us see what happens when there are abundant spots on *both* the east and west margins of the sun, so that the two sides balance one another. This is done in section E Table 9, and in the dot-and-dash line *E*, in figure 10. This line is based on 79 periods when the umbral area of the sun spots in the marginal 60° of the sun, taking east and west together, amounted to 100 or over, but when the quadrant differences did not exceed 50; such periods usually last only a day. About a quarter of them last two days, and a tenth three or four. Their curve is wholly different from lines *A* to *C* above it. It has two main maxima almost where the others have minima. The slight maximum in the center is apparently due to the fact that while we have excluded all days with a quadrant difference of above 50, we have not excluded those with a smaller quadrant difference. The days employed for line *E* are bound to have these small quadrant differences. Hence, there is likely to be a slight increase of storminess. The essential point of the whole matter is that a great abundance of spots on the margins of the sun does not seem to affect the weather unless the spots are so arranged that there is an excess in one particular quadrant.

In order that our tests may be as varied as possible, let us next see what happens when the sun spots in the marginal 60° of a given quadrant have an umbral area which exceeds that of the corresponding quadrant on the same side of the equator, by 100 or more. The results appear in sections *A* to *D* of Table 11 (p. 176), and in the four broken lines, *A* to *D*, of figure 13. Line *A* represents barometric changes in the northern section of the North Atlantic Ocean in relation to 39 periods when the umbral areas in the marginal part of the sun's northwestern quadrant exceeded the areas in the corresponding part of the northeast quadrant by 100 or more. The other lines represent similar conditions for each quadrant. It may be remarked in passing that as a rule the sun is not active in more than one quadrant at a time. For example, among the 148 periods used in preparing lines *A* to *D* only 30 are characterized by umbral areas of more than 100 in the marginal 60° of two quadrants at the same time. During the 10 years under consideration there was not a single instance of umbral areas exceeding 100 in the marginal 60° of three quadrants at the same time.

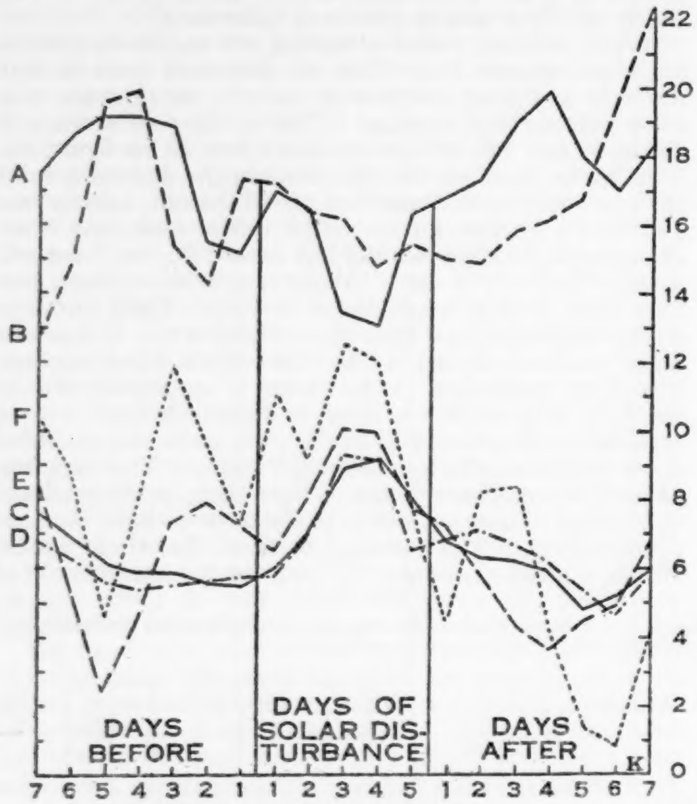
The interpretation of lines *A* to *D* in figure 13 is obvious. The two, *A* and *B*, which represent the sun's northern hemisphere, rise strongly during the times of their respective solar disturbances and reach a maximum

TABLE 10.—*Changes in barometric gradients in northern section of North Atlantic in reference to periods when a given group of sunspots produced a large quadrant difference on both margins of the sun, 1904–1913. (See figure 11, curve A.)*

	8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
SOUTH.																												
Average change	15.0	14.1	26.1	13.8	12.5	14.2	14.9	17.0	15.2	21.2	21.6	15.4	18.9	13.7	16.2	11.5	11.4	13.3	13.5	11.9	18.3	14.2	23.0	17.2	22.8	19.4	17.6	25.2
Sm. average	.....	17.3	20.0	16.6	13.3	14.0	15.3	16.0	17.2	19.8	20.0	17.6	16.8	15.6	14.4	12.6	11.9	12.8	13.0	14.0	15.7	17.4	19.3	20.1	20.6	19.0	20.0	....
NORTH.																												
Average change	20.7	20.5	15.6	10.9	15.8	16.9	18.1	14.5	18.3	13.3	20.1	16.9	22.0	14.9	20.6	16.5	15.7	14.7	19.5	16.6	16.9	13.8	22.7	14.1	13.5	9.8	14.0	17.1
Sm. average	.....	17.6	15.6	13.3	14.8	16.9	16.9	16.4	16.1	16.3	17.6	18.9	18.9	18.1	18.2	17.3	15.7	16.2	17.6	17.4	16.1	16.8	18.3	16.1	12.7	11.8	13.7	....
Total north and south sm. average change	.....	18.3	17.8	14.9	14.0	15.4	16.1	16.2	16.6	18.0	18.8	18.4	17.9	16.9	16.3	15.0	13.8	14.5	15.3	15.6	15.9	17.1	18.9	18.1	16.6	15.8	16.8	....

[3] In figure 10 the line *F*, marked by circles, shows still another way of testing our results. The line is computed in the same way as line *B*, but instead of taking the eastern and the western margins of the sun as units each margin is divided into a northern and a southern half. Then the difference between the east and west sides in the northern half is computed, and likewise the difference in the southern, and the two are added. This gives 148 periods instead of 144. The difference between the minima and the maximum amounts to 22 per cent and 17 per cent. Thus this method indicates less relationship than the one employed in the text.

on the third or fourth day, just as does the solid line A, in figure 10. Lines C and D, showing the relation of barometric changes to the sun's southern hemisphere, are



C and D are the same as in figure 10, A and C.
E, based on 25 days in 1904–1913, of highest quadrant differences.
F, based on the 10 days of very highest differences.

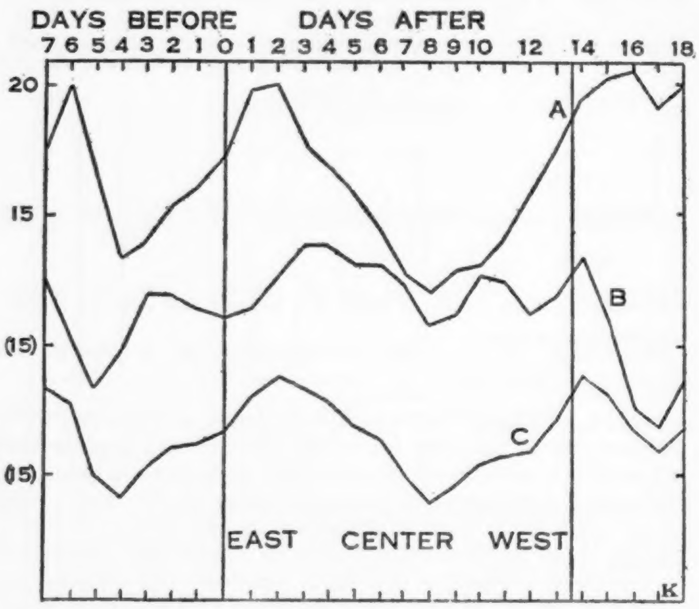
FIG. 11.—The degree of variability of the weather in the northern section of the North Atlantic at times of high quadrant differences.

similar to A and B, but rise less rapidly and markedly and reach their maxima later. In other words, an abundance of spots on the sun's margin has the same kind of effect no matter in which quadrant it is located. During the years 1904–1913, however, the effects produced by the southern solar hemisphere were less pronounced and less immediate than those of the northern. This accords with the fact that the days on which the southern figures are based had more than 50 per cent less solar activity than those of the northern figures.

In similar fashion in figure 13 the two dotted lines which pertain to the sun's eastern margin rise higher than the dash lines pertaining to the western margin. This suggests that spots on the eastern side are more important than on the western. It is opposed to the indications already discussed in relation to Table 1 and figure 4. Since these apparent differences seem to balance one another, they are probably due to chance. Apparently all four of the sun's quadrants are equally effective.

In analyzing the relation of the sun to terrestrial weather many puzzling results are found. In some cases the results of a given set of solar conditions may easily be confused with those of other allied conditions. For example, section E of Table 11 and line E in figure 13 seem to indicate the strongest kind of relationship between the earth and the sun. The maximum of the smoothed curve lies 145 per cent above the minimum that precedes it and 102 per cent above the succeeding minimum. This line is based on 14 periods showing a difference of 100 or more between the umbral areas on the east and west sides of the sun in both the northern and southern solar hemispheres.[4] When we use this same method on a larger scale, however, as is done in line F, figure 10, it does not give nearly so pronounced a result as the method of quadrant differences. The 14 periods used for line E, figure 13, are accompanied by quadrant differences averaging 122, so that these, rather than the contrast between the east and west sides, may be the cause of the apparent relationship.

Further confirmation of this conclusion is found in the four lower lines of figure 11. All of the lines represent the degree of variability of the weather in the northern section of the North Atlantic at times of high quadrant differences. Lines C and D are the same as A and C in figure 10. Line C shows the conditions in relation to 138 days having quadrant differences of over 100. Line D is based on 80 days on which the quadrant differences were a little more pronounced. Accordingly, C rises a little higher than A during the time of solar disturbance and falls a little lower 6 days afterwards. Line E is based on the 25 days during the period 1904–1913 showing the highest quadrant differences, while line F is based on the 10 days when the quadrant differences were highest of all.[5] The most significant fact about these four lines is the way in which the interval between the maxi-



A, southern groups. B, northern groups. C, both groups combined.

FIG. 12.—Effect of sunspot groups as they pass from the eastern to the western margin of the sun (compare Table 10).

mum during the time of solar disturbance and the succeeding minimum increases with the increase in the

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[4] The dates of these periods are as follows:
1906: June 28, July 7, Aug. 3, Dec. 15, Dec. 22–24.
1907: Feb. 26–27, May 12.
1908: Aug. 9–10, Aug. 25–28, Sept. 12–15.
1909: Jan. 25–27, Feb. 25, Mar. 4–6, Nov. 30, Dec. 2.

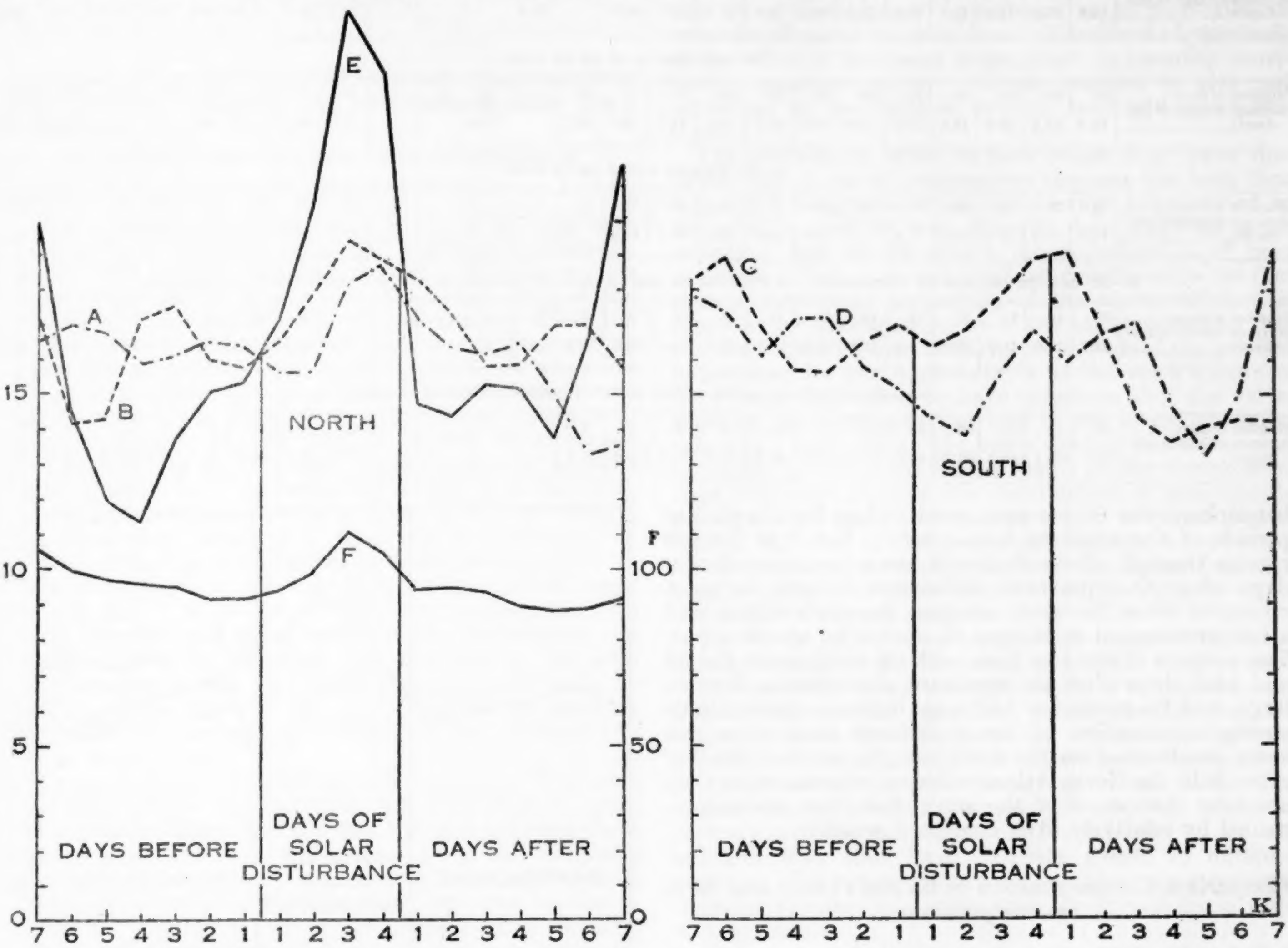
Line F in figure 13, based on F in Table 10, shows the variation in the actual strength of the gradients in the northern section of the North Atlantic for these same dates. We have said little about the gradients themselves, but in general their steepness is closely proportional to their change from day to day.

[5] The first days of these periods are as follows:
(A) 10 periods with largest quadrant differences:
1905: Jan. 29, July 19.
1907: Feb. 11, June 14, Sept. 27, Oct. 15, Nov. 17.
1908: Sept. 2.
1909: May 7, Sept. 10.
(B) 15 periods with next largest quadrant differences:
1904: Oct. 29, Dec. 7.
1905: Oct. 14, Dec. 22.
1906: July 7, July 29.
1907: June 22, July 12, Oct. 23, Nov. 9.
1908: Nov. 13, Dec. 27.
1909: Nov. 30.
1910: Feb. 25, Sept. 27

quadrant differences. In tabular form this may be expressed as follows:

	Per cent.
(1) Highest 138 days	29
(2) Highest 80 days	32
(3) Highest 25 days	47
(4) Highest 10 days	106

The rapidity with which these percentages increase is highly significant. So, too, is the low level to which the change in gradients falls at the minima representing the times when this particular type of solar effect is slight, either because of the absence of spots or because the western margin. Ten of these groups were in the sun's northern hemisphere and 10 in the southern. The change in barometric gradients in the northern section of the North Atlantic Ocean in respect to each of these periods appears in Table 10 and is plotted in figure 12. The day marked 0 is the day on which the solar disturbances first became evident, and thereby caused large quadrant differences. When spots were abundant in the southern hemisphere, line *A*, the gradients rose to a maximum within one or two days after the quadrant differences became high. Six days later, when the spots were near the sun's center, the change in barometric gradients fell



A, northwest greater than northeast.
B, northeast greater than northwest.
C, southeast greater than southwest.
D, southwest greater than southeast.
E, 14 periods showing a difference of approximately 100 or more, between the eastern and western margins both north and south of the solar equator.
F, resembles *E*, but is for gradients instead of changes in gradients.

Fig. 13.—Changes in barometric gradient from day to day in the northern section of the North Atlantic, in relation to periods when the areas of solar umbræ in the marginal 60° of one solar quadrant exceed those of the opposite quadrant on the same side of the solar equator by 100 millionths or more of the sun's surface (compare Table 11).

spots are concentrated near the sun's center. *Apparently when the quadrant differences or the accompanying weather-producing agencies of the sun's surface are particularly active, the North Atlantic Ocean alternates rapidly between periods of low gradients accompanied by remarkably little change of weather and periods of high gradients accompanied by storms.*

The truth of this conclusion may be illustrated in another way, as is seen in figure 12. Here 20 sunspot groups have been selected, because they gave rise to large quadrant differences when they appeared on the sun's eastern margin and again when they disappeared on the western margin.

very low, and the weather was comparatively steady. After another eight days the weather again became disturbed, and this disturbance apparently was connected with the quadrant difference caused by the presence of spots on the sun's western margin. The interval from one maximum to the other in this case is 14 days. It suggests that the maximum effect is produced when the spots are almost on the sun's limb.

Line *B*, figure 12, suggests that spots in the northern hemisphere have less effect than those in the southern. During the periods on which it is based the average intensity of the quadrant differences in the northern

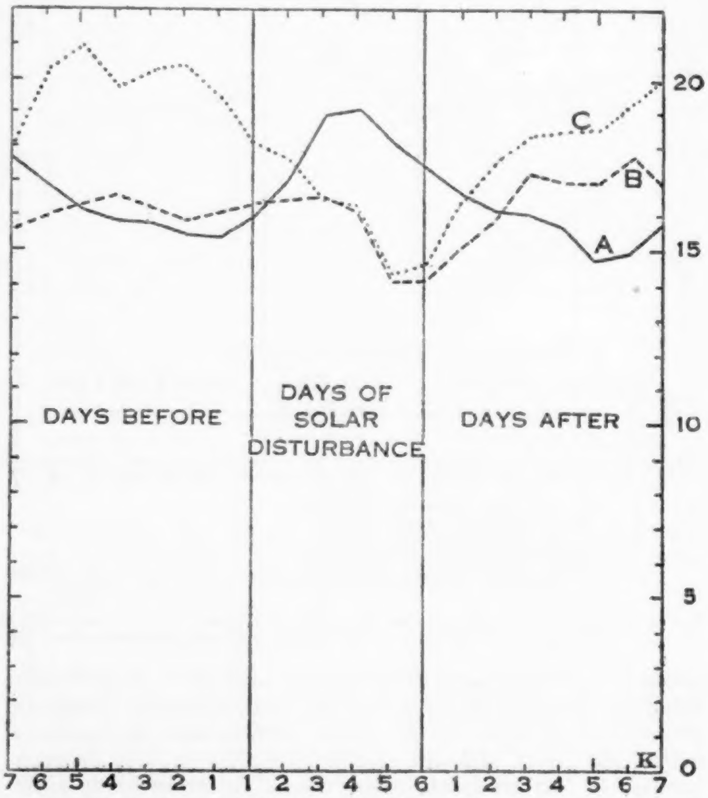
TABLE 11.—*Changes in barometric gradients in northern section of North Atlantic in relation to days having a difference of over 100 in umbral areas within 60° of sun's margin on opposite sides of the northern and southern hemispheres (see fig. 12).*

	Days before.								Days of solar difference.								Days after.							
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
A.—NW. EXCEEDS NE. BY 100 OR MORE.																								
Number of days	35	36	36	36	36	36	37	37	39	30	22	14	6	......	......	......	39	38	38	37	36	36	36	35
Average change of gradients	15.9	16.5	17.0	17.5	14.9	16.4	16.6	16.5	16.0	13.6	20.3	18.8	22.2	......	......	......	16.7	16.7	15.3	17.5	15.6	11.6	14.5	13.7
B.—NE. EXCEEDS NW. BY 100 OR MORE.																								
Number of days	26	26	27	27	27	27	27	27	30	26	20	15	2	1	......	......	30	30	30	28	27	27	26	26
Average change of gradients	18.3	19.5	12.1	13.4	18.9	17.6	16.1	14.5	17.8	15.5	23.7	15.3			......	......	19.7	17.4	14.9	16.1	16.6	18.7	14.1	16.2
C.—SW. EXCEEDS SE. BY 100 OR MORE.																								
Number of days	34	35	35	36	38	38	38	39	44	31	21	13	5	2	2	......	44	43	41	40	37	36	35	35
Average change of gradients	15.5	17.9	19.6	12.6	19.6	16.9	15.5	15.5	14.5	12.2	16.7	18.7	18.9			......	15.2	16.1	19.8	12.4	14.1	12.1	22.3	20.2
D.—SE. EXCEEDS SW. BY 100 OR MORE.																								
Number of days	29	29	29	29	31	31	31	32	32	25	22	17	5	......	......	......	32	32	32	32	30	29	29	29
Average change of gradients	17.6	16.6	22.4	14.2	17.2	14.3	16.9	17.9	15.2	17.4	18.0	17.7		......	......	......	21.0	16.4	13.9	13.3	14.4	14.7	13.2	15.8
E.—SE. EXCEEDS SW., AND NE. EXCEEDS NW., BY OVER 100; OR ELSE SW. AND NW. EXCEED SE. AND NE., RESPECTIVELY, BY OVER 100.																								
Number of days	10	10	11	11	12	12	14	14	14	8	6	3	......	......	......	......	14	14	14	14	10	10	10	10
Average change of gradients	21.7	23.6	11.3	15.2	6.2	17.8	13.4	15.9	16.0	22.4	30.0	25.0	......	......	......	......	14.2	13.6	16.3	15.1	13.6	12.4	27.8	18.1
F.—SAME AS "E," BUT GIVING ACTUAL GRADIENT INDICES INSTEAD OF CHANGES.																								
Number of days	10	11	11	11	12	12	14	14	14	8	5	3	......	......	......	......	14	14	14	14	11	11	11	10
Average of actual gradients	105.4	108.4	95.0	101.0	91.0	99.8	88.8	91.5	95.0	96.5	115.6	131.0	......	......	......	......	89.3	96.0	96.1	85.7	88.9	89.1	90.0	97.1

hemisphere was 80 per cent greater than for the similar periods of the southern hemisphere. Yet *B* is far less regular than *A*. Nevertheless it has a maximum 3 or 4 days after the quadrant differences become large, a minimum when the spots are near the sun's center, and a less pronounced maximum 11 days after the first one. The average of the two lines with its maxima on the 2d and 14th days after the quadrant disturbances become large, and its minimum half way between them affords strong confirmation of our conclusion that when sun spots are located on the sun's margin, stormy weather prevails in the North Atlantic Ocean, whereas when they are near the center of the sun's disk they are accompanied by relatively little change of weather.

Comparison between sunspots in the sun's center and barometric gradients.

Before leaving this part of our subject, let us turn from the sun's margin to its center. It will be recalled that stormy periods seem to occur at times when there are few spots in the central portion of the sun's disk. Let us now take the part of the sun within 30° of the central meridian and see how it is related to variability of the weather in the two sections of the North Atlantic. This is illustrated in lines *B* and *C*, figure 14, which are based on section *C* in Table 9. The solid line *A*, is the same as *A* in figure 10. The only difference is that here the 6th, 7th, and 8th days of solar disturbance have been separated from the 5th, thus increasing the width of the central section of the diagram. The other lines represent the degree of variation of the gradients from day to day in the northern section of the North Atlantic Ocean, *B*, and in the southern section, *C*, in relation to 110 periods when the umbral areas within 30° of the sun's central meridian amounted to 100 or more. Both



A, average daily change in gradient over the northern section of the ocean in relation to 138 periods when the area of the solar umbræ in the NW.+SE. quadrants of the sun visible disk at a distance of over 30° from the central meridian, differed from the area from the similarly located umbræ in the NS.+SW. quadrants by 100 millionths or more of the sun's visible area.

B, the same in relation to 110 periods with umbral areas of 100 millionths or more, within 30° of the central meridian.

C, the same as *B*, but for the southern section of the North Atlantic Ocean.

FIG. 14.—Changes in barometric gradients from day to day over the North Atlanti Ocean, in relation to solar activity (Table 9 *C*).

B and *C* take a marked drop at times when spots continue to be abundant in the sun's central area for 4 or 5 days. In the south, *C*, however, the drop is far more marked and begins earlier than in the north, *B*. The reversal between *C* and *A* is striking. It serves strongly to reenforce the idea that *storminess accompanies a lack of balance among the sun spots in the marginal portions of the sun, while quiet weather free from storms occurs when a balanced condition is produced either by the absence of disturbed areas on the sun's surface or by the concentration of such areas in the sun's center.*

(To be continued.)

CHANGES IN OCEANIC AND ATMOSPHERIC TEMPERATURES AND THEIR RELATION TO CHANGES IN THE SUN'S ACTIVITY.[1]

By Professor FRIDTJOF NANSEN, University of Kristiania.

[*Author's abstract* reprinted from Jour., Wash. Acad. Sci., Mar. 4, 1918, **8**: 135-138.]

The primary aim of the research was to find the relations existing between oceanic and atmospheric temperatures. The surface temperature of the water in various parts of the North Atlantic at the coldest time of the year formed the foundation of the first study. When the region covered by the data is divided into approximately equal areas, the temperature curves of these areas are found to be parallel, it is evident from the form of the curves that these changes of temperature, taken as a whole, are not due to changes in the water-masses transported. A relation does appear, however, between these changes and the prevailing direction of the wind, as deduced from atmospheric pressure gradients. Where the wind turns south of (i. e., is directed south of) its average direction over a period of years, the temperature of the water is lower than the average for the same period, and vice versa. A similar parallelism between wind direction and water temperature appears along the coast of Norway; the effect near the coast is based on the direction of the wind with respect to the land, as well as on the season of the year. The air temperature variations on land appear earlier than the variations in water temperature.

Certain periodicities appear in all the curves of oceanic and atmospheric temperatures, but they vary in type. At the same time a relation also appears between these curves and curves of sun-spot activity and magnetic elements. The 11-year period is prominent. An oceanic type and a continental (Eurasian) type can be distinguished. The latter follows the sunspot curve directly, whereas the former type follows the sunspots inversely. There is also a third and very remarkable type in which the curve changes more or less suddenly from direct to inverse. This sudden inversion is brought out in many curves, comparing stations in different parts of the earth, and the inversion occurs in very many cases at about the year 1896.

When the temperature curves for different months of the year are compared with the sunspot curves, these three types of agreement again appear in very puzzling and unexpected combinations.

In addition to oceanic and atmospheric temperatures, other meteorological elements (air pressure, wind velocity, rainfall, cloudiness, mean daily temperature-amplitude) show a relation to the sunspots, sun prominences, and magnetic variations, and show not only the 11-year period, but also shorter periods of two, three, and five and one-half years.

The fluctuations of the temperature at the earth's surface do not follow directly the variations in the energy received from the sun as determined by the measurements of Abbot and Fowle. The daily and yearly temperature-amplitudes are believed to furnish sufficient refutation of hypotheses based on supposed variations in the absorbing and reflecting power of the atmosphere, as well as of Humphreys' hypotheses as to formation of ozone or effects of volcanic dust. Blandford's hypothesis of the effect of increased evaporation in lowering continental temperatures at sunspot maxima is also not supported by the facts of tropical land and ocean stations.

The mistake of most authors when they have discussed the causes of temperature changes, has been that they took for granted that the average temperature at the earth's surface was directly dependent on solar radiation, and would give a direct indication of heat received. They have not considered sufficiently the fact that a very great proportion of the sun's radiation is absorbed by the higher layers of our atmosphere and that the distribution of heat in the atmosphere is of the greatest importance for the temperatures at the earth's surface. They seem very often to have forgotten that the variations in the sun's activity, and in the so-called "solar constant," and also in the sun's electric radiation, may primarily influence the higher layers of the atmosphere, thus indirectly guiding the distribution of atmospheric pressure and the circulation not only of these higher layers, but also of the lower parts of the atmosphere. In this manner the temperature of the higher latitudes may be influenced more than that of the Tropics where the conditions are so stable.

The variation in *pressure gradient* seems much more closely related to the temperature of land stations than is the variation in air pressure itself. For instance, the Colombo-Hyderabad gradient runs parallel to the temperature in the Himalayas but opposite to the temperature at Batavia, while Bombay forms an example of those strange reversals occurring about 1896. The Iceland-Azores gradient has exactly opposite effects in Norway and in mid-Atlantic. An increase of air circulation may thus have opposite effects in different regions. The sunspots and magnetic elements sometimes oppose and sometimes agree with the variations in pressure gradients.

Various periodicities appear in the sunspots as well as in the terrestrial phenomena. In the sunspots there is an 8-month period corresponding with the conjunction or opposition of the planets Venus and Jupiter with the sun. This same period occurs in the North Atlantic gradient, and was found by Krogness in the magnetic declination at Kristiania. There are also periods of six and twelve months in the magnetic elements, due to the position of the earth. The combination of these 6-, 8-, and 12-month periods gives a 2-year period for the magnetic and meteorological elements on the earth. But in the fluctuations of the sunspots a similar period of two years is also discovered, and specially noticeable are indications of minima every second year. Before 1896 there is an agreement between the 2-year minima of temperature at certain stations and the corresponding sunspot minima, but the agreement is remarkable in that the greatest depressions in the sunspot curve

[1] Illustrated review, before the Washington Academy of Sciences, Jan. 8, 1918, of the recent book.

Helland-Hansen, Bjørn, & Nansen, Fridtjof. Temperatur-Schwankungen des Nordatlantischen Ozeans und in der Atmosphäre. Einleitende Studien über die Ursachen der klimatologischen Schwankungen. Videnskapsselskapets Skrifter, I Mat.-naturv. Kl., 1916, No. 9. Kristiania, 1917. [viii, 341 p. charts. tables. 27½ cm.] This work is now in the Weather Bureau library.

coincide with the smallest depressions in the temperature curve; this relation ceased about 1896, hence the peculiar inversion already referred to.

Other periodicities have been recognized. A 32–33-month period at Batavia may be a combination of the 2-year period already referred to and a 3.7-year period suspected by Lockyer. Secular changes of relatively long period (35 years and over 100 years) also are probable. The researches of Clayton have recognized correlations in daily temperature and pressure fluctuations at various stations over the earth and the fluctuations in the daily heat radiation of the sun as measured by Abbot and Fowle, the same three types appearing in these meteorological variations as have been noted in the long-time variations. Krogness recognizes 14-day and 27-day periods in magnetic storms, as well as in air-pressure gradients, wind, and temperature, in northern Norway.

To summarize the results of these investigations: In different groups of areas on the earth the meteorological elements (temperature, barometric pressure, rainfall, etc.) fluctuate or pulsate, so to speak, in time with one another, while in other groups of areas the fluctuations or pulsations are exactly inverted, and finally, some areas show transition stages between the two. The result of all this is a very complicated picture of the meteorological fluctuations. But by means of appropriate analyses we see that from this complicated and apparently chaotic set of fluctuations there arises a clear picture of the very intimate relation between all these variations and the variations in the sun's activity. We have seen that even changes of very short duration in the sun's radiation (of heat as well as electricity) are distinctly repeated in our meteorological conditions and in the surface temperature of the ocean. The effects of the solar variations are probably transferred by means of variations produced in the distribution of pressure in our atmosphere. Changes in solar radiation probably first affect the higher layers of our atmosphere, and thus create an unrest which in turn is transmitted to the lower strata near the earth's surface.

Such dynamic changes will produce different effects in different regions of the earth. But by thorough and complete analyses of the great meteorological material now at hand it may be possible to find the general rules. This will be an important step forward toward understanding the laws ruling our atmosphere.

For this purpose it will also be of the greatest importance to have the wonderful researches of Abbot and Fowle continued with the greatest possible efficiency. These investigations of the sun's radiation of heat, which they have been carrying on for a long series of years at Washington, Mount Wilson, Mount Whitney, and in Algeria, have given us the remarkable revelation that our sun is a variable star, the most important discovery that has been made in this field in many years.

WHIRLWIND OF JANUARY 26, 1918, AT PASADENA, CAL.

By FORD ASHMAN CARPENTER, Meteorologist.

[Dated: Weather Bureau, Los Angeles, Cal., Apr. 18, 1918.]

On the afternoon of January 26, 1918, a whirlwind of considerable severity, showing many of the characteristics of a tornado, visited the city of Pasadena, Cal. Although the storm attained considerable violence and damaged property to the extent of about $10,000, no lives were lost and no one was injured. The material loss was widely distributed among one hundred or more persons. The storm was interesting from a meteorological viewpoint as it was the first of its kind reported from southern California.

The topographic features of Pasadena.—The topographical features of Pasadena should be taken into consideration in studying this storm.[1] The city is located 25 miles from the Pacific Ocean at the southern base of the Sierra Madre. These mountains rise abruptly to an average elevation of 5,000 feet above sealevel; an idea of the wall-like character of the northern background to the city may be gained from the fact that within four miles of Pasadena one of the crests of the range reaches an elevation of 5,000 feet above the city.

General and local weather conditions preceding the storm.—The morning weather map of January 26, 1918, showed a belt of high atmospheric pressure over the northern part of the country and a double-centered low

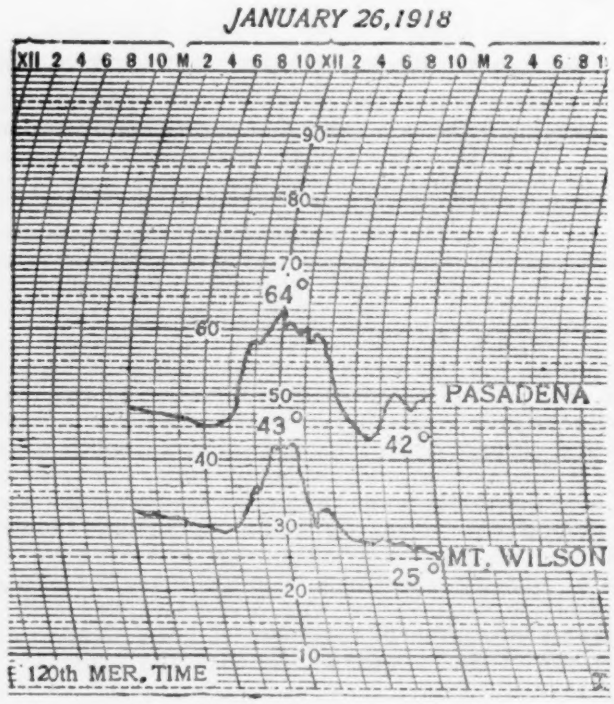


FIG. 1.—Thermograms from Pasadena, Cal., and Mount Wilson for Jan. 26, 1918, when hail and a whirlwind visited Pasadena in the afternoon.

area in Arizona, New Mexico, and Oklahoma. It was in the southwestern quadrant of this depression that the Pasadena storm occurred.

The first indication of unusual weather was the appearance of a solitary cloud which formed with great suddenness in that vicinity. The writer observed this huge convectional cloud from the Los Angeles station about 1:30 p. m. January 26, 1918, and it rapidly assumed the proportions and character of the cumulo-nimbus type. Within an hour this structure underwent rapid changes, but in three hours the sky was clear again. This cloud was observed from Mount Wilson (4 miles distant horizontally and 1 mile vertically) the upper edges appearing as a misting fog, boiling up 3,000 feet or more above that mountain. The temperature differences between the base and the top of the mountain amounted to about 20° F., as the thermograph traces from Pasadena and Mount Wilson show (fig. 1).

Course of the storm.—In many respects this whirlwind failed to follow the usual easterly course characteristic of

[1] For a topographic map of Los Angeles, Pasadena, and vicinity see this REVIEW, June, 1914, 42: 387.—C. A. jr.

FIG. 2.—Whirlwind of Jan. 26, 1918, at Pasadena, Cal., viewed from a point on Colorado Street between Fair Oaks and Marengo Streets, looking northward.) Photo. by E. P. Groetzinger.)

Note effect of wind on tree tops which point inward from either side showing decided anticlockwise motion of the wind. The funnel-shaped cloud was about 3,500 feet from the camera. Cooperative station seen in the middle distance, 1 block from the camera. Just over the flagpole on the left are seen two roofs (quadrilaterals) flying through the air.—*R. P. Hamlin, Cooperative Observer.*

tornados.[2] The path of this disturbance being one-quarter of a mile southeastward, one-half mile eastward, three-quarters of a mile northwestward, one-quarter westward and one quarter northwestward. The storm traveled in all about 2 miles of city blocks [along a path recurving anticlockwise as described] the average direction was northwesterly. Figure 2 [not reproduced] shows the path of the storm and also the locations of the cooperative Weather Bureau station of Pasadena. After the whirlwind left the city limits it continued in a northwesterly direction and ascended the mountain ridge between Mount Lowe and Mount Markham. The writer noticed the effects of this storm when traversing the trail in that vicinity some weeks afterwards. One of the cooperative observers in these mountains reports that he heard the approach of the storm and the crashing of the pine trees as it plowed its way through the timber. Shortly after reaching the higher elevations the storm died out; the writer did not observe any damaging effects beyond the mountain ridge in which Mount Lowe and Mount Markham are located.

Description of the storm by eye-witnesses.—Fair weather prevails in southern California during more than three-quarters of the year, therefore any occurrence out of the ordinary is given unusually intelligent attention by the people generally. The case of the Pasadena storm was no exception to the rule. From a quantity of data collected the following two accounts are submitted. Prof. Ferdinand Ellerman of the staff of the Mount Wilson Solar Observatory writes Dr. W. J. Humphreys of the central office of the Weather Bureau as follows:

On January 26 [1918], we had a freak storm in Pasadena, where hail fell several inches deep in a very limited area, just as if it had been dumped, and a small-sized cyclone [!] did considerable damage. About 200 yards from my residence a pine tree over 2 feet through was uprooted, and many buildings unroofed, and barns and garages picked up and demolished. As near as I can learn the direction of rotation was clockwise, which, though contrary to cyclones in general, is not surprising to me, as considering the form of development it might take either direction. The sky on Mount Wilson was practically clear, and fog condensing from the slight rain the night before, increased in volume and banking up quite 3,000 feet above Mount Wilson's level, in a cumulus form. There was very little wind in Pasadena and a fair north wind on Mount Wilson. This occurred about 2 to 2:30. From the mountain we could not see the cyclone [i. e. tornadic storm] as the fog cut off the view.

From the notes of the cooperative observer at Pasadena, Mr. R. P. Hamlin, deputy city engineer, it has been possible to trace the path of the storm across the city.

Mr. Edwin R. Sorver, former cooperative observer at Pasadena writes:

The day was somewhat cloudy. About 2 p. m. it became very dark and a small tornado developed in the neighborhood of Fair Oaks Avenue and Union Street, traveling in a southeast direction for 2 blocks to Colorado Street and the Santa Fe tracks, tearing off roofing paper and blowing in a show window. It then followed Colorado Street east for 4 blocks, now and then becoming quite strong. A small amount of rain fell and hail fell. At Colorado Street and Euclid Avenue it blew in another show window and then turned directly at right angles going north and then northwest, which direction it kept until it dispersed. It now [after turning northwestward] began to grow very much in strength, uprooting large trees, taking the entire roof off an old school and striking the side of the Christian Church at Marengo and Walnut Streets. This church was built of large squares of concrete blocks. It demolished the entire side, throwing down several solid blocks together which probably weighed several tons. Its path, which was about 200 feet wide, could now be easily traced as it uprooted every tree, among them some very large peppers, and took off a number of roofs. Considerable damage was also caused by trees and débris, which were carried high up and then dropped (in one instance) through a house which was to one side of its path. The worst damage was done around the corner of Orange Grove Avenue and Lincoln Streets, soon after which it dispersed. Here an entire orange grove of old trees was uprooted. This was on the place where the first house in Pasadena was built, which was still standing and was unhurt. It partly demolished a bungalow school, took the top off a church, completely wrecked a large garage, took the side out of a two-story house, and did considerable damage to other houses. The most remarkable part was that no one was hurt. The very black clouds did not follow the tornado, but moved off in the opposite direction. Snow and hail fell some 2 to 3 miles distant. There were, however, some white, low clouds which seemed to follow right over the tornado and which it connected with the ground many times. After it left Euclid Avenue and Colorado Street going northwest it appeared as a large and high whirling column of dust. Gradually, however, as it grew in strength it became a black funnel-shaped column resembling a waterspout. Once or twice it seemed to almost disappear, but then in not over five seconds would resume its old form. It did not seem to travel so very fast. At times there would be sucked through the center of it a fairly large column of what looked to be steam; this no doubt being intense condensation. The white clouds would then dip down into the column. It seemed to disperse very quickly as it moved into a section that was more open.

The above notes were made from Mr. Sorver's location in the Mather Building [No. 3, on fig. No. 2, not reproduced].

Deputy City Engineer R. P. Hamlin furnishes the photograph, figure 2, which shows the whirlwind just before it reached its maximum intensity. This illustration shows the counterclockwise wind movement as pictured by the inclination of the tree tops. Incidentally the location of the wind apparatus of the cooperative Weather Bureau station is given. Although the storm skirted this apparatus it is noted that the anemometer wind record sheet [not reproduced] shows no unusual velocities. The maximum wind, 18 miles per hour (the usual diurnal extreme), was reached at 2 p. m.

Several interesting incidents of the storm are related. A member of the Forest Service reports his aneroid barometer broken from the effects of the passage of the storm, the diaphragm being permanently collapsed. Another witness reports all four of the tires of his automobile, standing in the street, as having been deflated. It is also reported that just before the cottage [fig. 4 not reproduced] was destroyed the occupant started to close the kitchen door which had been blown open by the wind; before the door was reached the house was unroofed and the sides blown outward. All of these occurrences point strongly to tornadic action.

[2] e. g., *Henry, A. J.* Cyclones, tornadoes, thunderstorms, squalls. Monthly Weather Review, January, 1918, 46: 23-25.

EVAPORATION FROM A CIRCULAR WATER SURFACE.[1]

By N. Thomas and A. Ferguson.

[*Reprinted from* Science Abstracts, Sect. A, Jan. 31, 1918, § 71.]

The rate of evaporation from a circular water surface into a quiescent atmosphere was shown by Stefan to depend theoretically upon the radius of the surface, not upon its area. Experiments were made by the authors, both indoors and in the open air to test the dependence of evaporation upon the dimensions of the surface of evaporation, and upon the depths of the surface below the rims of the crystallizing dishes containing the water which varied in radius from 2 to 10 centimeters. If E is the rate of evaporation and a the radius of a dish, then assuming that $E=Ka^n$ where K depends on external conditions, it is found that in practice n is never so small as unity, the value required by Stefan's result, but varies from 1.5 when the dish is brimful, to about 2.0 when the depth of the surface is 3 centimeters or more below the brim of the dish. With the latter value, evaporation is proportional to the area of the evaporat-

[1] Phil. Mag., London, etc., October, 1917, 34: 308-321.

ing surface, and the method of expressing amount of evaporation by depth of water evaporated is justified. With the former value of n the depth of water evaporated varies inversely as the square root of the radius of the dish.—*R. C[orless]*.

REDETERMINATION OF HEAT OF VAPORIZATION OF WATER.[2]

By J. H. MATHEWS.

[*Reprinted from* Science Abstracts, Sect. A, Jan. 31, 1918, § 77.]

The author has redetermined the heat of vaporization of water, using the method devised by Richards and the author [Abstract 902 (1911)]. The apparatus employed has been improved more especially by the substitution of a vaporizer made of transparent quartz for those made of glass; and a better type of adiabatic calorimeter has been introduced. The water equivalent of the calorimetric system having been accurately determined, the author found that the heat required to vaporize 1 true gram of water into a vacuum at 100° is 539.0 $\text{calories}_{15°}$. Using another value of the water equivalent of the apparatus determined by an electrical method, the value for the heat of vaporization was found to be 540.0 $\text{calories}_{15°}$, a number that is in good agreement with that obtained by Smith, viz, 540.7 calories.—*A. F[indlay]*.

SUGGESTIONS AS TO THE CONDITIONS PRECEDENT TO THE OCCURRENCE OF SUMMER THUNDERSTORMS, WITH SPECIAL REFERENCE TO THAT OF JUNE 14, 1914.

By J. FAIRGRIEVE.

(*Abstract* of a paper presented to the Royal Meteorological Society, London, Apr. 17, 1918.

[*Reprinted from* Nature, London, May 2, 1918, **101**: 179.]

The paper deals particularly with the thunderstorm of June 14, 1914. The meteorological phenomena accompanying the rainfall are put on record. The cloud distribution, the barometric pressure, the wind movements, and the temperature are specially dealt with. From an examination of the data it is evident that the clouds and the rainfields lie in parallel belts, and that the former appear some hours before the rain begins to fall. It is suggested that this belting of wind and rain may be due to rippling on a large scale, the rippling being brought about by the interaction of two currents of different temperatures. If the conditions are unstable, and especially if relief also induces disturbance, thunderstorms will develop along lines of rippling, and will drift with the wind. Thunderstorms have apparently three movements, a development along a belt, a sideways movement in the direction of the prevailing wind, i. e., to leeward, and a spread to windward. The first may be due to rippling; the second is a drift; the third may be explained if it is granted that a local ridge of high pressure develops along the axis of the thunderstorm. The thunderstorm then breaks up into two belts, of which the leeward soon dies out owing to the lack of a supply of rising air.

Topographic conditions from Allegheny Front eastward specially favor studies testing this theory.—C. A. jr.

[2] Jour. phys. chem., October, 1917, **21**: 536-569.

EARTHQUAKE WEATHER.

The term "earthquake weather" is often encountered in California, but meteorological textbooks do not mention it. Those who use the term are unanimous in referring to a condition of hot and calm weather, without much cloud, but usually more or less haze. The condition is not greatly unlike that which usually precedes a summer afternoon thunderstorm in the Middle West. As the term "earthquake weather" has not yet become commonplace in scientific literature it would be interesting to learn what seismologists think about the matter.

The above paragraph appears in a recent issue of the Bulletin of the Seismological Society of America[1] in comment on the statement by Wendell P. Hoge, of the Mount Wilson Solar Observatory, that the 'quake of July 15, 1917, 11:05 a. m. at that observatory came with—

Weather partly cloudy, wind south, 3 mis./hr., relative humidity about 30 per cent, temperature 87°. General character of the weather for several days such as is often spoken of as "earthquake weather."

Readers of the MONTHLY WEATHER REVIEW may be interested in the following summary of what has been published on the subject so far in these pages.

South Australia.—Geo. H. Styles, of Port Caroline, South Australia, reported that during the month preceding the earthquake of May 10, 1897, there, the weather had been thick and squally with the wind all round the compass. On the day of the disturbance the wind force, which had been 6 to 8 for several days, fell to 2; the direction from the northeast and the weather fine with Ci.St. clouds.

At the same place in 1900 to March, 1901, 'quakes were accompanied by a sky usually covered with heavy Cu., "one or two of them bright, as though lighted by the moon, even during the darkest moonless nights." The cumuli never coalesced but if one overtook another they were mutually repelled, drifting away in feathery flakes and dissolving into clear sky before reaching the horizon. The sky was no longer the blue of the old days but of a milky, watery color.[2]

Jamaica, B. W.I.—Maxwell Hall reports that there are not enough earthquakes in Jamaica to permit a complete investigation of a possible relationship between them and weather phenomena. He states that the cause of the oppressive weather noticed before an earthquake is the stopping or diminution of the wind. The barometer is also affected and St. tends to form.[3]

Japan.—Omori found that maximum earthquake activity generally coincides with times of high atmospheric pressures; but that just the reverse is true at some stations where it usually is accompanied by low barometric readings. The apparent contradiction has been explained away by Dr. K. Honda.[4]

California.—The California earthquake of April 18, 1906, called forth an interesting paper from San Francisco students,[5] in which the atmospheric conditions are described and commented on. That morning—the weather map for the day indicates the conditions throughout the United States just a few minutes previous to the 'quake—was clear and pleasant over the greater portion of the Pacific coast. A HIGH was moving steadily and somewhat slowly eastward across Idaho, and the pressure distribution was of a type that prevails when certain earthquakes occur in California. While experience in

[1] See *Andrew H. Palmer:* California earthquakes during 1917. Bull., Seism. soc. America, Stanford University, California, March, 1918, **8**: 10.
[2] *Styles, Geo. H.* "Earthquakes, clouds, and gales at Port Carolina, So. Austr." MONTHLY WEATHER REVIEW, January, 1902, **30**: 10.
[3] *Hall, Maxwell.* The Jamaica weather service. MONTHLY WEATHER REVIEW, July, 1898, **26**: 304.
[4] See *Tamura's* abstract of Honda's paper, "Daily periodic changes in the level of artesian wells in Japan. MONTHLY WEATHER REVIEW, July, 1905, **33**: 303-304.
[5] *Richter & McAdie.* Phenomena connected with the San Francisco earthquake. MONTHLY WEATHER REVIEW, November, 1907, **35**: 505.

California has shown that earthquakes apparently have no relation to pressure distribution, yet some occur during the passage of a marked HIGH across the northern portion of the coast. Somewhat similar pressure conditions had occurred at the beginning of April and at other times.

Weather Bureau records maintained through to 5 p. m of the 18th show that the westerly wind of about 14 miles per hour with clear sky and pleasant weather, characteristic of April 17, 1906, had become a west wind of 3 mis/hr., with clear sky at a few minutes preceding the quake at 5:13 a. m. on the 18th, and at 5 p. m. of that day the wind velocity had risen to 22 mis/hr. The weather was that of "a pleasant spring day" with nothing remarkable. The pressure (sealevel) at 5 p. m. was 30.15 inches, temperature 61.8°F., and wet-bulb thermometer 54.0°

COMMENT.

Prof. W. J. Humphreys, in a recent conversation on this subject, made the very interesting suggestion that the "earthquake weather" concept is of psychological origin; that the general state of irritation and sensitiveness developed in us during the hot, calm, perhaps sultry weather given this name, inclines us to sharper observation of earthquake disturbances and accentuates the impression they make on our senses, so that we retain more vivid memories of such quakes while possibly overlooking entirely the occurrences on other more soothing days.—C. A., jr.

SECTION III.—FORECASTS.

FORECASTS AND WARNINGS, APRIL, 1918.

By ALFRED J. HENRY, Supervising Forecaster.

[Dated: Weather Bureau, Washington, May 18, 1918.]

PRESSURE OVER THE PACIFIC AND ALASKA.

April is the month of highest normal pressure of the year at both Honolulu, T. H., and Midway Island. At the former place pressure during April, 1918, was continuously below the normal, while at the latter pressure was below the normal only on April 1–2, 14–16, and 19–22. At other times, especially for the 10-day period 4th–14th, pressure was markedly above the normal. There was very little synchronism between the pressure fluctuations at the two stations.

Had pressure at Midway been uniformly low as at Honolulu, it would have been justifiable to assume that the normal April HIGH over the north central Pacific Ocean for the present season would be weaker than usual; but the lack of synchronism between the two points made it hazardous to interpret the uniformly low pressures recorded at Honolulu.

In the Aleutian Islands pressure was mostly above the normal except for the period April 8–14, when there was a well-marked barometric depression that later overspread coastal and interior Alaska and the northern portions of the United States. After the middle of the month pressure was generally high both on the coast and over the interior of Alaska.

THE WEATHER IN THE UNITED STATES.

There were few abnormal features in the weather of the United States proper during April, 1918. Temperature was low for the season in the middle Rocky Mountains and Plateau region and thence eastward into the lower Ohio Valley. Rainfall was abundant in the South and there was considerable snow at the higher altitudes of the Rocky Mountain States; but the snow melted quickly.

An attempt to correlate the above conditions with the pressure distribution over the Pacific and Alaska is deferred until more observational data in the Pacific have been obtained.

In April the movement of HIGHS and LOWS begins to depart from the normal paths of the cold-weather types. The departure, in many cases, is small and not easily recognized; west of the Continental Divide, however, the change in the frequency and direction of movement of LOWS is rather well marked. The southeastward movement from the States of Washington and Oregon, characteristic of the cold season, practically ceases and there is evidence of a well-marked tendency toward the development of secondary depressions over the southern portions of Utah and Nevada as the primary depressions move eastward along the northern circuit, or fill up. The movement of these secondaries is generally erratic and difficult to anticipate; nevertheless, they exercise a marked control of the weather in Rocky Mountain States.

In April, 1918, no primary depression moved southeastward from the northern Pacific Coast States, but 5 secondaries occupied the region west of the Continental Divide and south of the 40th parallel at one time or another. East of the Rocky Mountains the LOWS were about equally distributed between the northern and the southern circuits, and but few LOWS passed from one circuit to the other. There was also, throughout the month, a distinct tendency to form secondary depressions when for any reason the progress of the primary depression was obstructed.

Extremes in the weather, due to the shifting control by cyclones and anticyclones, were specially frequent in the middle and southern Rocky Mountain States, due to the development of secondary depressions in that region in connection with the eastward and southward advance of anticyclones.

HIGHS.

The HIGHS (anticyclones), of which the paths of 9 have been plotted on Chart II, show no unusual features. Five of the 9 must be considered merely as offshoots from the principal HIGHS. On the chart the offshoots are distinguished from the principal HIGHS by a subscript letter after the number.

In general HIGHS diminished in intensity with movement to lower latitudes, but there were two cases where an increase in intensity, i. e., an increase in the central pressure, occurred as the HIGH moved eastward. An increase in the central pressure of No. *I* occurred as soon as it reached the Atlantic; No. *II* showed the greatest increase over Lake Superior; No. *IV* showed the greatest increase over the lower Lakes where its eastward progress was greatly reduced. HIGH No. *V*A, beginning as a remnant of No. *V* with an initial pressure of but 30.10 inches in western Montana, slowly increased in intensity as it moved east-southeastward, attaining a maximum pressure of 30.52 inches in Kentucky on May 3. The apparent cause of the increase in this case was a corresponding increase in the intensity of the LOW which immediately preceded it.

While the advent of a HIGH is generally equivalent to a brief spell of fair weather, the combination HIGH on the north or northeast–LOW on the south or southwest in April is generally tantamount to a spell of unseasonable weather with snow in northern districts, thundershowers and warm weather in southern districts. Cases illustrating this condition occurred on several dates during April, 1918, in the Rocky Mountains Region; also in the New England and Middle Atlantic States on the 11th, 12th, and 13th. The storm along the Atlantic coast from the Virginia Capes to Boston on those dates was practically continuous for about three days. Fresh northeasterly gales with high tides swept the coast and caused much damage to and destruction of beach property. There was also some loss to shipping at anchor in New York Harbor. The snowfall in interior districts extended as far westward as northeastern Indiana, and in Vermont the fall amounted to at least 7 inches in localities. Fortunately, there was no loss of life, although the property loss will aggregate close to $1,000,000.

The sustained high northeast winds during the storm period were due to the eastward advance of HIGH No. *II*, which seemingly prevented LOW *I*A (see Chart III) and its offshoot, *I*B, from advancing directly northeastward on the normal path. Inasmuch as the HIGH was of more than ordinary intensity the wearing-down process was a slow one. As an indication of the drift of the lower air out of the region occupied by the HIGH, it may be said that the surface wind at Washington, D. C., shifted to the northeast at 11 p. m. on April 9 and continued uninterruptedly from that direction for 40 hours; the speed of the wind when the shift occurred was 24 miles per hour,

and it continued at that rate for 24 hours, dropping to 15 miles per hour at the end of the period.

During this time there was a dense cloud layer moving in the direction of the surface wind. Precipitation in the form of rain began on the 8th and was practically continuous after 6 p. m. of that date, turning to snow during the 11th. The total amount for the four days was 3.53 inches. The suggestive thought, however, is what a tremendous amount of water vapor was carried inland over the Middle Atlantic States as evidenced by the amount collected at a single point; and, second, considering the volume of air carried bodily southwestward from the southeastern face of the HIGH as well as the loss due to condensation of water vapor, is it not remarkable that pressure in the HIGH should not sink to a lower level than it did? In that part of the HIGH where air was continually moving away from the center the reduced pressure was highest, 30.46 inches at 8 a. m. of the 10th, and it sank gradually to 29.90 inches by 8 a. m. on the 13th. Thereafter it rose as the wind shifted to the northwest.

LOWS.

The paths of 16 LOWS of greater or less intensity have been platted in Chart III. It is not easy to distinguish between the so-called primary and secondary LOWS in April. It is customary to think of practically all primary LOWS as reaching North America from the Pacific on the west, or from tropical waters on the south and southeast. For the month of April, as has already been indicated, there is a decided break in the continuity of movement. This change is undoubtedly a seasonal one and is probably a direct result of surface warming in the arid and semiarid region of the far Southwest whereby local centers of buoyancy are initiated in the levels a kilometer or so above the surface. Because of the prevailing aridity in this region, these incipient LOWS cause little precipitation, except on the west side and in the rear with the advance of anticyclonic conditions. Because of the fact that these LOWS may remain practically stationary for several days at a time, it is difficult to anticipate their influence upon weather conditions east of the Rocky Mountains.

In this April 5 LOWS occupied the far Southwest at one time or another, and 3 other LOWS had their origin in the Rio Grande Valley. Several of these have been classed as principal LOWS, but the great majority were secondary depressions. The details of their movement can be seen from Chart III. The severe weather in New England and the Middle Atlantic States, above described, was due to the inability of LOW *IA* to advance northeastward on April 10.

WARNINGS ISSUED.

An extensive and unusually prolonged display of storm warnings on the Atlantic coast began on April 9 with the issue of northeast warnings from Norfolk to Boston. The storm center after reaching southeastern Virginia on the morning of the 10th, seemed to be on the point of filling up, but 12 hours later what appeared to be a new storm center appeared on the South Carolina coast. This center advanced northeastward, keeping a short distance off the coast, causing moderate to fresh northeast gales from Cape Cod to the Virginia Capes. On the night of the 11th the warnings were extended from Boston to Eastport, Me. The greatest severity of the storm winds was experienced, however, along the Middle Atlantic coast as already stated.

Warnings were again displayed on the Atlantic coast on the 17th and 21st. In both cases they failed of verification.

Another display was made on the 26th from Charleston to Boston. This storm was quite severe along the Virginia and North Carolina coasts, thence it pursued a northeast course some distance offshore and gave no storm winds north of Cape Henry. On the 28th, however, heavy sea swell and increasing northeast winds were reported from Nantucket, but by that time the center was far off to sea and no further indication of its presence was received.

Storm warnings on Great Lakes.—The season for the display of storm warnings began on April 20 when a display was made on account of a disturbance over western Tennessee. The disturbance advanced over the Great Lakes, but the barometric gradient slowly decreased and the warnings were only partially verified. Warnings were again displayed on the Great Lakes on the 28th and 29th. These warnings were also only partially justified although a sharp fall of temperature with snow on Lake Superior on the 30th made navigation difficult.

Frost warnings.—Frost warnings were issued for some part of the Washington forecast district on April 5, 8, 9, 12, and 19.

WARNINGS FROM OTHER DISTRICTS.

Chicago, Ill., forecast district.—The warnings issued during April, 1918, were confined to frost warnings at intervals, and to cattle or sheep warnings on the 2d and 25th. The interests in Illinois and Missouri demanded frost warnings from the first of the month, and warnings were sent to these States on the 7th, 8th, 9th, 10th, and 12th, and they were in every case fully verified.

The area covered by frost warnings was gradually extended northward and westward, embracing by the 30th all the States in the district, except the Dakotas, Montana, and Wyoming. Warnings of freezing temperature were issued for a considerable area on the 18th and 19th, and as the minima promised to fall to exceedingly low points, advices were sent even to the Dakotas. By the morning of the 20th the temperature was down to freezing, or below, from Lake Michigan westward over the upper Mississippi Valley to and including the northern Rocky Mountains region, and reaching as far south as Kansas and northwestern Missouri on the west. The entire area was fully warned in advance.

Additional warnings were issued on the 22d for frost in Wisconsin and Nebraska and freezing temperature in Minnesota. Warnings of frost again went out on the 27th for Nebraska and Kansas, and on the 28th for those States, together with Iowa, Missouri, and Wisconsin, and warnings of freezing temperature for Minnesota. On the 30th frost warnings were again issued for Illinois, Missouri, Wisconsin, and the eastern portions of Minnesota and Iowa. As a result of the critical temperatures vegetable growth was much retarded in the area affected. It is not known what actual benefits were derived from the warnings.

The live-stock warnings issued on the 2d for Missouri, Nebraska, Kansas and southeast Wyoming and on the 25th for South Dakota, Wyoming, and Nebraska were specially for the sheep interests—it being the lambing and shearing seasons—as the temperatures were not low enough to affect larger live stock. It is believed that these warnings were of much value, as strong northerly winds with freezing temperature and some snow followed.—*H. J. Cox, District Forecaster.*

New Orleans, La., forecast district.—Frost warnings were issued during April, 1918, as follows: For Oklahoma and northern Arkansas, April 7; Arkansas, April 9; the greater portion of the district, April 10; eastern

portion of Louisiana and Arkansas, April 11; Texas Panhandle and northwestern Oklahoma, April 16; Oklahoma and the northern portion of west Texas, April 17; Oklahoma, northern portion of western Texas and the extreme northwestern portion of eastern Texas, April 19; over the northern portion of the district, April 20; Oklahoma, Arkansas, and the interior of Louisiana, April 21; Oklahoma and northwestern Arkansas, April 28; Oklahoma and northwestern Arkansas, April 30. The warnings were generally justified.

Small-craft warnings were issued for the western Gulf Coast on April 6. Storm winds occurred locally on a few dates on the Texas coast, but there was no general storm without warnings.—*I. M. Cline, District Forecaster.*

REPORT ON SPECIAL WARNINGS ISSUED IN THE DENVER DISTRICT.

Denver, Colo., forecast district.—Unsettled weather predominated in the Denver district during April, 1918; there were few days without a low-pressure area somewhere in the district. Of the sixty 12-hour periods in the month, temperatures were below the seasonal average 25 periods in Colorado and 16 periods in half of Colorado. In Utah, 17 periods were colder than the seasonal average and 10 in half of that State. In New Mexico the duration of the warm and cold periods was about equally divided, while in Arizona there was a slight preponderance in the duration of the warm periods.

On the morning of the 2d low pressure prevailed in southern districts, the axis of the depression extending from Nevada eastward to Missouri, while high pressure prevailed from the Pacific northwest to the Lakes region. Live-stock warnings were issued for eastern Colorado and northern Utah. During the next 24 hours the front of the anticyclone moved southward east of the Continental Divide, attended by freezing weather, with snow in northeastern Colorado and snow flurries and sleeting weather in parts of southeastern Colorado. While temperatures in Utah and eastern Colorado remained low for several days, no damage of consequence to fruit interests resulted, owing to the backward condition of orchards. The benefits derived from the snowfall more than offset any damage that occurred. On the evening of the 13th a deep low-pressure area was central in southern Nevada, with isobars of the depression extending northward to Alberta, while relatively high pressure prevailed along the Pacific. Live-stock warnings were issued for northern and western Utah. Rain fell in northern Utah the following night, attended by a decided fall in temperature.

Forecasts of freezing temperatures were included in the daily forecasts on 16 dates for parts of Colorado, Utah, and New Mexico, and practically all were fully verified. General distributions of these warnings were unnecessary, owing to the backward condition of fruits and gardens.—*Frederick H. Brandenburg, District Forecaster.*

San Francisco (Cal.), forecast district.—During April, 1918, rainfall in this district was deficient and the temperatures averaged above normal. There were several severe frosts in northern California during the first few days, and frosts occurred frequently in the northern Pacific States throughout the month. Practically no rain fell during the last 15 days, and the need of it for crops was beginning to be felt in the north and becoming urgent in the south at the close of the month.

Small-craft warnings were ordered on the morning of the 8th at northern Pacific seaports, and on the 14th along the southern coast of California.

Storm warnings were ordered on the 8th at 11:10 a. m. along the northern California coast, and extended that evening to include all northern Pacific stations. This warning was fully verified in California and partially verified in the northern Pacific States. On the 13th a steep barometric gradient developed between the mouth of the Columbia River and Sitka, Alaska; and consequently southwest storm warnings were ordered at 6:30 p. m. at the entrances to the Strait of Juan de Fuca and the Gulf of Georgia, and also at the mouth of the Columbia River. No high winds occurred during the following night and the warnings were taken down early the next morning.

Frost warnings were issued for one or more places in the northern Pacific States on 16 days, and on 8 days in northern California. Nearly all of these warnings were verified, and no damaging frosts formed without ample warnings having been sent to the places where the frosts occurred.

Live-stock warnings were sent to places in eastern Oregon, southern Idaho, and Nevada on the 2d; to eastern Oregon, eastern Washington, Idaho, Nevada, and the northern half of California on the 12th; and to southeastern Washington, eastern Oregon, Idaho, and Nevada on the 24th. All of the live-stock warnings were verified, and the following telegram was received from the Antelope Valley Land & Cattle Co. on the 13th, in acknowledgment of the warning sent that company on the 12th:

Topaz, Cal., *April 12, 1918.*

Mr. Beals,
United States Weather Bureau,
Merchants Exchange Building, San Francisco, Cal.

Have notified owners representing over 100,000 new-born lambs contents your telegram. All feel very grateful and wish expression of thanks conveyed to you. This company intended to commence shearing to-morrow, but will defer until after the storm. High, cold southwest wind blowing here now. Many thanks.

Antelope Valley Land & Cattle Co. 10:35 p. m.

Two weather and temperature forecasts, one on the 2d and the other on the 18th, failed of justification. The first affected the eastern and southern portions of northern California. It was expected that a low over Utah on the evening of the 1st, which had remained nearly stationary during the following 12 hours, would continue stationary long enough to cause showers where predicted; but although it remained stationary for 24 hours and caused good rains in Nevada and showers in southern California, none was reported at stations within the northern California area where rain had been predicted.

The other forecast was made on the morning of the 18th, when showers and cooler weather were predicted for the second period of the forecast in the northern portion of northern California, western Oregon and western Washington. The mistake was made of misjudging the extent of the high over the ocean. It was thought the low over western British Columbia and the relative low pressure over California would form a trough-shaped depression within the next 24 hours, that would extend from California northward over western Oregon and western Washington into British Columbia. Within this trough of low pressure cloudiness was expected to increase and be followed by showers, and the cloudiness and showers would have caused lower temperatures. Instead, the high moved northward causing northerly winds and clear weather during the period, and the forecast was a failure.—*E. A. Beals, District Forecaster.*

SECTION IV.—RIVERS AND FLOODS.

RIVERS AND FLOODS, APRIL, 1918.

By ALFRED J. HENRY, Meteorologist in Charge.

[Dated: River and Flood Division, Weather Bureau, May 27, 1918.]

With the passing of April the probability of a serious flood in the lower Mississippi during the season of 1917–18 vanished. The highest stage reached at Cairo, Ill., was 39.8 feet, about 5 feet below flood stage, on February 25; at Memphis, Tenn., the highest stage lacked 10 feet of flood stage and at Vicksburg the crest of the spring rise lacked 7 feet of flood stage. All of the above stages were recorded on the rise produced by the breaking up of the ice in the Ohio during the closing days of February, 1918.

In the northern districts, notwithstanding a winter of severe cold and fairly heavy snowfall, the ice passed out of the rivers almost without damage by gorging or flooding.

In April, 1918, there were few flood-producing rains although quite a few short-lived floods occurred in the rivers of the South Atlantic drainage, but as a rule they were local and short-lived. The details are shown in Tables 1, 2, and 3 below.

Losses in April, 1918, due to floods.

District.	Bridges, highways, etc.	Crops.		Farm property, live stock, etc.	Suspension of business.	Value of warnings
		Gathered.	Prospective.			
Shreveport, La	$700	....	$2,500	$17,500	$150	$30,000
Columbia, S. C	....	$1,000	2,000	385	3,712	68,527
Dallas, Tex	....	....	6,250	....	....	125,000
Mobile, Ala	....	....	10,000	....	....	....
Raleigh, N. C	5,000	....	20,000	....	20,000	15,000
Richmond, Va	100	....	....	....	500	30,000
Charleston, S. C	5,000	1,300	7,500	500	28,000	39,000

Hydrographs for typical points on several principal rivers are shown on Chart I. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.

TABLE 1.—*Flood stages in Atlantic and eastern Gulf drainages during April, 1918.*

River and station.	Flood stage.	Above flood stages—dates.		Crest.	
		From—	To—	Stage.	Date.
ATLANTIC DRAINAGE.					
Connecticut:	*Feet.*			*Feet.*	
Hartford, Conn	16	3	6	18.8	4
White River Junction, Vt	13	2	6	17.9	3
Do	....	10	10	13.0	10
White:					
White River Junction, Vt	15	3	4	17.6	3
Susquehanna:					
Wilkes-Barre, Pa	20	....	....	18.1	17
James:					
Columbia, Va	18	11	11	18.5	11
Do	....	21	23	20.9	21
Richmond, Va	10	22	23	12.2	22
Roanoke:					
Randolph, Va	21	22	22	23.6	22
Weldon, N. C	30	11	14	36.5	11
Do	....	22	25	40.2	24
Dan:					
Clarksville, Va	12	....	....	11.5	23
Tar:					
Rocky Mount, N. C	9	14	14	9.0	14
Tarboro, N. C	18	16	17	18.9	16
Do	....	25	27	18.7	26
Greenville, N. C	13	15	19	14.0	17–18
Do	....	24	(**)	14.7	28
Fishing Creek:					
Enfield, N. C	14	12	14	15.7	13
Neuse:					
Neuse, N. C	14	11	13	15.3	12
Do	....	22	25	16.5	23
Smithfield, N. C	13	11	16	15.7	13–14
Do	....	21	26	17.4	23
Cape Fear:					
Elizabethtown, N. C	22	22	28	33.9	24
Fayetteville, N. C	35	22	24	45.6	23
Waccamaw:					
Conway, S. C	7	22	23	7.0	22–23
Do	....	26	(**)	9.1	30
Haw:					
Moncure, N. C	22	22	22	22.4	22
Peedee:					
Cheraw, S. C	27	21	24	35.8	22
Santee:					
Rimini, S. C	12	11	15	13.1	13
Do	....	21	(**)	14.7	27
Ferguson, S. C	12	13	18	12.7	15–16
Do	....	24	(**)	13.6	27
Catawba:					
Catawba, S. C	11	....	....	10.5	21
Wateree:					
Camden, S. C	24	21	23	28.2	21
EAST GULF DRAINAGE.					
Coosa:					
Lock No. 4 (Lincoln, Ala.)	17	....	....	16.0	11
Black Warrior:					
Tuscaloosa, Ala	46	9	9	46.1	9

** Continued into May.

TABLE 2.—*Flood stages in Mississippi drainage during April, 1918.*

River and station.	Flood stage.	Above flood stages—dates. From—	Above flood stages—dates. To—	Crest. Stage.	Crest. Date.
Mississippi:	*Feet.*			*Feet.*	
Hannibal, Mo	13			10.6	4–5
Illinois:					
Peru, Ill	14			13.0	1
Peoria, Ill	16			14.9	1–2
Henry, Ill	7	(†)	5	13.7	*18–19
Do		7	7	7.0	7
Grand:					
Brunswick, Mo	10			9.8	4
Meramec:					
Steelville, Mo	12	26	26	15.6	26
Pacific, Mo	11	19	19	11.0	19
Do		26	(**)	20.4	28
Valley Park, Mo	14	19	19	15.0	19
Do		26	(**)	25.0	28
Bourbeuse:					
Union, Mo	10	26	(**)	15.7	30
Atchafalaya:					
Melville, La	31			30.9	30
Wabash:					
Mt. Carmel, Ill	15			14.8	30
White:					
Elliston, Ind	19			18.3	6
Tennessee:					
Riverton, Ala	32			29.2	11
Missouri:					
Blair, Nebr	16			15.5	1
Omaha, Nebr	19			17.1	1
Petit Jean:					
Danville, Ark	20	18	19	21.0	18
Black:					
Black Rock, Ark	14	30	(**)	14.0	30
Cache:					
Jelks, Ark	9			8.3	25–26
Red:					
Index, Tex	27			24.5	19
Fulton, Ark	28	21	21	28.1	21
Sulphur:					
Finley, Tex	24	10	14	26.0	10–11
Do		19	24	26.6	21
Ringo Crossing, Tex	20	7	9	23.0	8
Do		17	20	21.6	18
Cypress:					
Jefferson, Tex	18	24	24	18.4	24
Ouachita:					
Arkadelphia, Ark	18			17.4	7
Little:					
Whitecliffs, Ark	28			27.0	21

† Continued from March. * February. ** Continued into May.

TABLE 3.—*Flood stages in western Gulf and Pacific drainages during April, 1918.*

River and station.	Flood stage.	Above flood stages—dates. From—	Above flood stages—dates. To—	Crest. Stage.	Crest. Date.
WEST GULF DRAINAGE.					
Trinity:	*Feet.*			*Feet.*	
Dallas, Tex	25	15	21	29.9	20
Trinidad, Tex	28	20	25	28.5	24–25
Colorado:					
Columbus, Tex	24			22.7	18
Guadalupe:					
Victoria, Tex	16	1	1	18.6	1
PACIFIC DRAINAGE.					
American:					
Folsom City, Cal	10	10	10	10.0	10

MEAN LAKE LEVELS DURING APRIL, 1918.

By UNITED STATES LAKE SURVEY.

[Dated: Detroit, Mich., May 4, 1918.]

The following data are reported in the Notice to Mariners of the above date:

Data.	Lakes.* Superior.	Michigan and Huron.	Erie.	Ontario.
Mean level during April, 1918:	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Above mean sealevel at New York	601.46	581.40	572.25	247.17
Above or below—				
Mean stage of March, 1918	−0.15	+0.34	±0.00	+0.56
Mean stage of April, 1917	−0.79	+0.62	−0.35	+0.93
Average stage for April, last 10 years.	−0.13	+0.27	−0.15	+0.75
Highest recorded April stage	−1.23	−1.83	−1.93	−1.26
Lowest recorded April stage	+0.92	+2.18	+0.99	+2.33
Average relation of the April level to—				
March level	±0.0	+0.3	+0.7	+0.7
May level	−0.3	−0.4	−0.4	−0.4

* Lake St. Clair's level: In March, 574.61; in April, 574.46 feet.

SECTION V.—SEISMOLOGY.

SEISMOLOGICAL REPORTS FOR APRIL, 1918.

W. J. HUMPHREYS, Professor in Charge.

[Dated: Seismological Investigations, Weather Bureau, June 4, 1918.]

TABLE 1.—*Noninstrumental earthquake reports., April, 1918.*

Day.	Approximate time, Greenwich Civil.	Station.	Approximate latitude.	Approximate longitude.	Intensity Rossi-Forel.	Number of shocks.	Duration.	Sounds.	Remarks.	Observer.
		ARIZONA.								
1918.	H. m.		° ′	° ′			M. s.			
Apr. 20	8 45	Flagstaff	35 12	111 37	2	1	Few.	Faint		G. T. Herrington.
	10 20	Flagstaff	35 12	111 37	2	1	Few.	Faint		G. T. Herrington.
21	22 30	Aztec	32 49	113 28	3	1	10	None	Gradual rocking	M. Hawkins.
		Bouse	33 57	114 01	5	2	15	None	Gradual trembling NW-SE	E. L. Short.
		Crozier	35 24	113 40	3	1	10	None	Abrupt rocking, windows shook.	W. H. Turk.
		Kingman	35 11	114 04	4	1	Few.	None		Arizona Gazette.
		Mohave City	35 02	114 38	5	1	Few.	None	Gradual rocking N-S	Merle O. Smith.
		Oatman	35 02	114 25	5	1	Few.	None	Abrupt rocking	Barbara J. Shearer.
		Parker	34 10	114 17	5	1	Few.	None	Rocking NW-SE	M. E. Brown.
		Quartzsite	33 40	114 11	5	2	30	None	Gradual rocking, NE-SW	J. L. Wilson.
		Salome	33 47	113 37	4	1	Few.	None		Arizona Gazette.
		Seligman	35 19	112 51	1	1	Few.	None		San Francisco Chronicle.
		Somerton	32 35	114 43	4	2	Few.	None	Gradual rocking, water in buckets slopped over, NW-SE.	M. A. Hoffponir.
		Truxton	34 18	113 36	3	1	Few.	None		Arizona Gazette.
		Wellton	32 40	114 08	4	1	Few.	Faint	Rattling, gradual rocking, W-E.	G. J. Schultheis.
		Wenden	33 49	113 32	4	2	Few.	None	Abrupt trembling	August Nord.
		Yucca	34 52	114 09	4	1	30	Rumbling	Vibration, NW	Louis Janc.
		Yuma	32 45	114 36	5	1	03	Faint	Rattling, abrupt rocking, E-W; clock stopped.	U. S. Weather Bureau.
28	12 20	Flagstaff	35 12	111 37	1	1	Few.	None	Single sharp bump	G. T. Herrington.
	12 58	Flagstaff	35 12	111 37	5	1	15	Low	Rumble, slight rocking	G. T. Herrington.
		CALIFORNIA.								
17	6 45	Eureka	40 48	124 11	5	2	30	Rumbling	Gradual trembling, N-S	Geo. E. Kammerer.
		Eureka	40 48	124 11	5	2	20	Faint	Gradual trembling, N-S, ending with 2 distinct bumps, first bump strongest.	Lawrence M. Monfort.
21	22 30	Aguanga	33 27	116 55	8	3	24	Rumbling	Rapid trembling, N-S, shocks continued through night with one next morning.	Paul Thomsen.
		Bagdad	34 35	115 52	5	2	05	None	Rapid rocking, E-W	T. R. Morgan.
		Banning	33 55	116 53	9				Front of I. O. O. F. building fell out.	San Francisco Chronicle
		Bonita	32 39	117 03	5	3	30	Rumbling	Rapid rocking, NE-SW	R. M. Allen.
		Barrett (6 miles north)	32 42	116 41	5	4	04	Loud	Rumbling; gradual rocking, SE-NW.	L. Watts.
		Barstow	34 54	117 02	4	2	20	Faint	Rumbling; gradual rocking, SE-NW.	E. L. White.
		Beaumont	33 55	117 00	8	2	3 10	Faint	Rapid rocking, N-S; chimneys fell.	K. R. Smoot.
		Beaumont (5 miles north)	33 59	117 00	2	1	05	None	Abrupt trembling, N-S	K. R. Smoot.
		Blythe	33 35	114 41	4	3	1 00	None	Gradual rocking, S-N and E-W.	Iva M. Grober.
		Cabazon	33 55	116 47	8				2 railroad water tanks toppled over.	San Francisco Chronicle.
		Cahuilla	33 32	116 45	9	4-5	15	Rumbling	Rapid rocking. Nearly everything on shelves of store thrown to floor. Dust clouds on Mount Thomas immediately indicated land slips. Tremors continued throughout afternoon and night.	Hartwell W. Gardner.
		Calexico	32 41	115 30	5	1	3 00	Faint	Rumbling; gradual rocking, NE-SW.	H. M. Rouse.
		Calexico	32 41	115 30	6	Several.	3 00	Yes	Water barrel slopped over, N-S. Automobiles moved, N-S, about 4 feet. Triangle iron swinging free described an ellipse.	I. R. Ralston.
		Claremont	34 06	117 43	6	1	1 30	Faint	Rumbling. Gradual, quite strong, rocking, E-W. Clock stopped, pendulum swung N-S for 20 minutes.	260 East Third Street.
		Claremont	34 06	117 43	6	1	2 30	Moderate	Rapid trembling E-W, ending N-S.	F. P. Brackett.
		Corona	33 53	117 34	6	1	15	None	Abrupt rocking	Thomas C. Seas.
		Corona	33 53	117 34	1	1	Few.	None	Faint secondary shock 17 minutes after last above.	Thomas C. Seas.
		El Cajon	32 48	116 59	6	1	2 00	Rumbling	Abrupt rocking and trembling	E. P. and P. G. Kessler.
		El Cajon	32 48	116 59	1	1	Few.	None	Secondary shock 18 minutes after last above.	E. P. and P. G. Kessler.
		Escondido	33 07	117 06	6	1	25	Loud	Rumbling and bumping	H. L. Harlow.
		Escondido	33 07	117 06	1	1	10	None	Secondary shock 12 minutes after last above, trembling continued till end of hour.	H. L. Harlow.
		Fairmont	34 45	118 26	6	3		Faint	Rumbling. Abrupt twisting, E-W.	Wm. F. C. Lowe.

TABLE 1.—*Noninstrumental earthquake reports, April, 1918*—Continued.

Day.	Approximate time, Greenwich Civil.	Station.	Approximate latitude.	Approximate longitude.	Intensity Rossi-Forel.	Number of shocks.	Duration.	Sounds.	Remarks.	Observer.
		CALIFORNIA—continued.	° ′	° ′			M. s.			
1918. Apr. 21	*H. m.* 22 30	Fontana	34 06	117 27	5	1	20	Loud	Rumbling. Abrupt rocking, E-W.	J. Lundemo.
		Fresno	36 43	119 49	2	1		None	Chandeliers swayed	W. E. Bonnett.
		Hemet	33 44	116 58	10	2	40	Loud	Every business house laid flat. Building losses appraised at $75,000.	San Francisco Chronicle.
		Imperial	32 51	115 33	8				Railroad watertank toppled over.	San Francisco Chronicle.
		Indio	33 43	116 13	9	3	55	Rumbling	Rapid rocking and twisting, E-W. Great dust clouds arose on San Jacinto Mountains. Buildings damaged.	Bruce Drummond.
		Julian	33 04	116 36	6	2	15	Rumbling	Abrupt bumping and trembling.	J. H. L. Vogt.
		Laguna Beach	33 31	117 47	5	2	05	Rumbling	Abrupt rocking NE-SW	Wendell P. Hoge.
		Los Angeles	34 03	118 15	8	1	40	Loud	Rumbling, abrupt bumping, then rocking E-W and twisting, clock stopped, doors opened.	A. W. Pugh.
		Mecca	33 34	116 05	5	3	1 00		Water thrown out of irrigation ditches and reservoirs over a bank 3 feet high. Clouds of dust rose from canyons in the mountains.	Edgar A. Palmer.
		Mesa Grande	33 10	116 46	5	1+	1 00	Rumbling	5 or 6 secondary slight shocks followed during next 4 hours.	Edward H. Davis.
		Mount Lowe	34 13	118 08	8	1	07		Rapid rocking E-W, and up and down.	Edward Lucien Larkin.
		Mount Wilson	34 13	118 04	8	2	30		Abrupt rocking NE-SW. Rocks on mountain side dislodged	A. H. Joy.
		Nellie	33 19	116 52	8	3	12	None	Abrupt bumping and rocking S-N.	Esther P. Hewlett.
		Nellie	33 19	116 52		1	04	None	Slight secondary shock 19 minutes after above.	Esther P. Hewlett.
		Nellie	33 19	116 52		1	04	None	Slight third shock 29 minutes after first one, and several slight tremors later.	Esther P. Hewlett.
		Newhall	34 23	118 33	5	1	20		Rapid rocking	P. J. Coyle.
		Ojai	34 25	119 12	5	1	05	None	Abrupt rocking E-W	Wm. H. Duncan.
		Point Loma	32 43	117 15	6		10	None	Rapid rocking SE-NW	Fred J. Dick.
		Pomona	34 03	117 45	4	1	10	None	Abrupt twisting NE-SW	John E. Adamson.
		Redlands	34 03	117 11	9				Several buildings wrecked	San Francisco Chronicle.
		Rialto	34 06	117 22	4	2	10	Loud	Rumbling, trembling 7 seconds SE-NW, then a heavy twist for 3 seconds.	J. B. Witts.
		Riverside	33 59	117 23	7				Ornaments shook from courthouse cornice. Plate glass broken.	San Francisco Chronicle.
		San Bernardino	34 06	117 18	9				Wall 100 feet long of low brick building fell out.	San Francisco Chronicle.
		San Bernardino Mountain.	34 07	116 56	9		30	Loud	Rumbling, mountain rocked like a cradle. Trees lapped N-S.	J. M. Henry.
		San Diego	32 43	117 10	6	1	Few.	None	Abrupt bumping and rocking E-W and N-S. Clock stopped. Milk bottle toppled over. Rocking chairs rocked.	Dean Blake.
		San Diego	32 43	117 10	5	2	05	None	First trembling, second twisting.	Archibald Campbell.
		San Diego (Camp Kearny 15 miles north).	32 56	117 10	4	2		None	Rapid rocking	Capt. Harry J. Willey.
		San Jacinto	33 46	116 58	10	2	40	Loud	Rumbling. Every business house laid flat. Building losses appraised at $150,000.[a]	San Francisco Chronicle.
		Santa Anna	33 46	117 53	8	1	47	Rumbling	Gradual rocking E-W	R. L. Bisby.
		Santa Monica	34 02	118 30	6	3	20	None	Gradual rocking SW-NE	W. F. Bates.
		Valley Center	33 13	117 04	7	5	1 20	Loud	Rumbling. Abrupt bumping and rocking.	Ben Amago.
		Venice	33 58	118 28	6	4	25	None	Abrupt rocking SW-NE	Dr. James T. Brown.
		Victorville	34 32	117 18	6	1	05	Loud	Rumbling, abrupt rocking N-S. Clock stopped. Articles thrown from shelves.	Virginia Messick.
		Victorville	34 32	117 18		1	01	None	Secondary faint shock a half-hour after above.	Virginia Messick.
		Victorville	34 32	117 18	5	3	37	Rumbling	Concrete tank cracked	G. H. Matthews.
		Warner Springs	33 17	116 39	8	1		None	Plaster and adobe walls cracked.	J. A. Ream.
		Warner Springs	33 17	116 39		1	Few.	None	Secondary shock 15 minures after above.	J. A. Ream.
		Whitewater	33 54	116 38	9				Two buildings collapsed	San Francisco Chronicle.
		Whittier	33 58	118 04	8				Slight damage	San Francisco Chronicle.
		Winchester	33 42	117 06	9				Earth slip buried 2 men in magnesite mine. Both rescued.	San Francisco Chronicle.
		Workman	33 55	118 11	8	2	1 02		Frame house on wood posts rocked to and fro. Two doors hinged N-S opened. Door hinged E-W closed.	F. H. Staverman, scientific assistant, Batavia Observatory, Java.
22	Morning.	Aguanga	33 27	116 55		1			Faint shocks continued from 21st through night, with one on morning of 22d.	Paul Thomsen.
23	5 03	Calexico	32 41	115 30	4	1	15	Faint	Rumbling. Abrupt bumping E-W.	H. M. Rouse.
	7 00	Hemet	33 44	116 58	4	1	Few.		Windows shook, dishes rattled	San Francisco Chronicle.
	9 00	Hemet	33 44	116 58	4	1	Few.		Windows shook, dishes rattled	San Francisco Chronicle.
	14 15	Hemet	33 44	116 58	5	1	Few.		Windows shook, dishes rattled	San Francisco Chronicle.

[a] Center of disturbances apparently San Jacinto fault, in Baptiste Canyon, 7 miles east of San Jacinto.—San Francisco Examiner.

TABLE 1.—*Noninstrumental earthquake reports, April, 1918*—Continued.

Day.	Approximate time, Greenwich Civil.	Station.	Approximate latitude.	Approximate longitude.	Intensity Rossi-Forel.	Number of shocks.	Duration.	Sounds.	Remarks.	Observer.
		CALIFORNIA—continued.								
1918.	H. m.		° ′	° ′			M. s.			
Apr. 23	7 00	San Jacinto	33 46	116 58	4	1	Few.		Windows shook, dishes rattled	San Francisco Chronicle.
	9 00	San Jacinto	33 46	116 58	4	1	Few.		Windows shook, dishes rattled	San Francisco Chronicle.
	14 15	San Jacinto	33 46	116 58	5	1	Few.		Windows shook, dishes rattled	San Francisco Chronicle.
24	9 55	Warner Springs	33 17	116 39	2	1	Few.	None	Gradual rocking	J. A. Ream.
25	3 00	San Jacinto	33 46	116 58		1	Few.			San Francisco Examiner.
	7 00	San Jacinto	33 46	116 58		1	Few.			San Francisco Examiner.
	10 05	Warner Springs	33 17	116 39	3	1	Few.	None		J. A. Ream.
26	11 00	Mesa Grande	33 10	116 46	2	1	01	Faint	Trembling	Edward H. Davis.
	12 00	Mesa Grande	33 10	116 46	2	1	01	Faint	Trembling	Edward H. Davis.
27	5 30	Cahuilla	33 32	116 45	3	1	01	Rumbling	Gradual trembling, N-S	Hartwell W. Gardner.
		San Jacinto	33 46	116 58		1	Few.			Associated Press.
	6 00	Mesa Grande	33 10	116 46	2	1	01	Faint	Trembling	Edward H. Davis.
	10 00	Cahuilla	33 32	116 45	4	1	01	Rumbling	Gradual rocking, N-S	Hartwell W. Gardner.
	15 00	Cahuilla	33 32	116 45	3	1	01	Rumbling	Gradual trembling NE-SW	Hartwell W. Gardner.
	22 30	Cahuilla	33 32	116 45	3	1	01	Faint	Rumbling; gradual trembling N-S.	Hartwell W. Gardner.
29	2 00	San Jacinto	33 46	116 58	5	1	Few.		Rocked tables and furniture	Los Angeles Times.
	12 00	San Jacinto	33 46	116 58	3	1	Few.		Rocked tables and furniture	Los Angeles Times.
		DISTRICT OF COLUMBIA.								
10	1 09	Washington	38 54	77 03	3	1	01	None	Gradual trembling	Local observers, press reports.
		MARYLAND.								
		Bagley	39 30	76 23	1	1	01	None	Gradual trembling	D. Curtiss.
		Baltimore	39 17	76 37	2	1	01	None		The Baltimore News.
		Chewsville	39 38	77 37	4	1	Few.	Loud	Like blasting; gradual trembling SW.-NE.	D. E. Oswald.
		Clear Spring	39 37	77 55				None	5 large panes of glass found broken next day.	M. W. Frantz.
		College Park	38 58	76 55	3	1	01	None		Thomas H. White.
		Solomons (?)	38 19	76 27	4?	1?	1? ..	Faint?	Rumbling; abrupt trembling. (Reports time 31 minutes too late.)	W. H. Marsh, M. D.
		Takoma Park	38 58	77 01	3	1	01	None		L. M. Mooers.
		Woodstock	39 19	76 52	2	1	01	None		Press report.
		PENNSYLVANIA.								
		Colebrook	40 26	76 04	2	1	01	None	Gradual trembling	Wm. A. Rorer.
		VIRGINIA.								
		Buchanan	37 32	79 41	1	1	01	None	Gradual trembling	D. D. Booze.
		Columbia	37 45	78 13		1	02	None	Like a violent wind	A. B. Payne.
		Culpepper	38 29	77 58	5	3	1 30	None	Abrupt rocking	R. E. Miller.
9	18 08	Dale Enterprise	38 27	78 55	1	1	01	None	Trembling	L. J. Heaterole.
10	1 09	Dale Enterprise	38 27	78 55	3	2	03	Rumbling	Abrupt trembling	L. J. Heaterole.
		Danville	36 34	79 26	2	1	Few.	None	Gradual rocking	Charles Alderson, Lewis Mitchell.
		Gordonsville	38 09	78 11	3	2	30	None	Rapid trembling	J. C. Graves.
		Guinea	38 09	77 26	1	1	04	None	Gradual trembling W-E	M. J. McNair.
		Harrisonburg	38 25	78 52	5				Rocking motion	Staunton Morning Leader.
		Luray	38 41	78 27	5-6		1 ..			Staunton Daily News.
		Lynchburg	37 25	79 09	2	1	04	None	Gradual trembling	R. C. Williams.
		New Canton	37 43	78 23	5	2	20	None	Abrupt trembling	Plummer F. Jones.
		Orange	38 15	78 07	5	1		Rumbling	Abrupt rocking	Miss Cleo Benedict.
		Rapidan	38 19	78 04	3	2	1 ..	None	Gradual trembling	F. H. Calnahan.
		Richmond	37 32	77 27	3	1		None	Gradual rocking NW-SE	Mrs. Robert Currie.
		Roanoke	37 16	79 56	2	1	05	None	Gradual rocking	R. F. Bell.
		Staunton	38 10	79 04	4	2	1 ..	Rumbling	Gradual trembling NE.-S	E. J. Cushing.
		University	38 02	78 31	5	1	30	Rumbling	Like quite heavy thunder; abrupt trembling SW-NE.	S. A. Mitchell.
		White Post	39 04	78 07	4	1	1 ..	None		Staunton Daily News.
		Williamsburg	37 16	76 43	2	1	01	None		W. E. Momier.
		Winchester	39 10	78 10	4	1	30	Rumbling	Like a heavy truck running; abrupt trembling.	Walter I. Cooper.
		Woodstock	38 53	78 31	5	1		Rumbling	Like a heavy railroad train; gradual trembling E.-W.	Tirzah L. Miley.
16	12 40	Luray	38 41	78 27		1		None	Windows rattled; fifth shock within a week.	Associated Press.
21	15 ..	Norfolk	36 51	76 17		2	Few.	None		Associated Press.
		Suffolk	36 43	76 35		2	Few.	None		Associated Press.
		WEST VIRGINIA.								
10	1 09	Buckhannon	38 59	80 15	2	1	Few.	None	Gradual trembling	Mrs. H. A. Darnall.
		Martinsburg	39 28	77 58	5	1	07	Rumbling	Gradual bumping	George W. Van Metre.
		UTAH.								
21	22 30	Milford	38 24	113 01	1	1		None		San Francisco Chronicle.
		WASHINGTON.								
18	20 13	White Bluff Prairie (8 miles west of Spokane).	47 40	117 35	4	1	04	Faint	Rumbling; rocking N-S	Mrs. A. D. Currie.

TABLE 2.—*Instrumental reports, April, 1918.*

(Time used: Mean Greenwich, midnight to midnight. Nomenclature: International.)

[For significance of symbols see REVIEW for January, 1918, p. 34.]

Alaska. *Sitka.* *Magnetic Observatory.* U. S. Coast and Geodetic Survey. J. W. Green.

Lat., 57° 03′ 00″ N.; long., 135° 30′ 06″ W. Elevation, 15.2 meters.

Instruments: Two Bosch-Omori, 10 and 12 kg.

Instrumental constants: $\begin{cases} E & 10 & 16 \\ N & 10 & 15 \end{cases}$ (V, T_0)

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Apr. 14	....	e_N	8 32 42	5				E driving clock being repaired.
		M_N	8 32 46			60		
		F	8 42 ..					
21	....	eP_N	22 38 10	5				Do.
		S_N	22 42 58	12				
		eL_N	22 45 36	24				
		M_N	22 49 46	12		350		
		C	22 50 ..					
		F	23 58 ..					

Arizona. *Tucson.* *Magnetic Observatory.* U. S. Coast and Geodetic Survey. F. P. Ulrich.

Lat. 32° 14′ 48″ N.; long., 110° 50′ 06″ W. Elevation, 769.6 meters.

Instruments: Two Bosch-Omori, 10 and 12 kg.

Instrumental constants: $\begin{cases} E & 10 & 14 \\ N & 10 & 18 \end{cases}$ (V, T_0)

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Apr. 17	....	eP_E	6 49 14					
		eP_N	6 49 18					
		M_N	6 52 23	10		20		
		M_E	6 52 30	12	50			
		C	6 54 ..					
		F	7 06 ..					
21	....	eP_N	22 33 50	9				N stylus off paper from 22h35m16s to 22h38m15s.
		eP_E	22 33 58	8				
		eL_N	22 35 10	16				
		eL_E	22 35 19	10				
		M_E	22 36 34	8	6,900	8,920+		
		C_E	22 39 ..	12				
		F_E	23 34 ..	8				
27	....	e	14 56 45	12				Nothing on N.
		M	15 02 ..	12	30			
		F	15 04 ..	12				

California. *Berkeley.* *University of California.*

Lat., 37° 52′ 16″ N.; long., 122° 15′ 37″ W. Elevation, 85.4 meters.

(See Bulletin of the Seismographic Stations, University of California.)

California. *Mount Hamilton.* *Lick Observatory.*

Lat., 37° 20′ 24″ N.; long., 121° 38′ 34″ W. Elevation, 1,281.7 meters.

(See Bulletin of the Seismographic Stations, University of California.)

California. *Point Loma.* *Raja Yoga Academy.* F. J. Dick.

Lat., 32° 43′ 03″ N.; long., 117° 15′ 10″ W. Elevation, 91.4 meters.

Instrument: Two-component, C. D. West seismoscope.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Apr. 13					100	100		
21	VI		22 33 ..		4,500	6,000		Tremors during 24 hours preceding. No magnification, but N-S component is absolutely astatic for an amplitude (half swing) of only 10 mm., and the E-W component for an amplitude of 5 mm. For the first time in 12 years a distinct vertical component was registered with an amplitude of 0.5 mm. True amplitudes are therefore estimated as 50 per cent of those recorded horizontally. Horizontal acceleration is estimated to have been between 400 mm. and 600 mm. per sec. per sec. Duration 7 to 10 seconds.

California. *Santa Clara.* *University of Santa Clara.* J. S. Ricard, S. J.

Lat., 37° 26′ 36″ N.; long., 121° 57′ 63″ W. Elevation, 27.43 meters.

(See Record of the Seismographic Station, University of Santa Clara.)

Colorado. *Denver.* *Sacred Heart College.* Earthquake Station. A. W. Forstall, S. J.

Lat., 39° 40′ 36″ N.; long., 104° 56′ 54″ W. Elevation, 1,655 meters.

Instrument: Wierchert 80 kg., astatic, horizontal pendulum.

Instrumental constants ....

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Apr. 10-11.	....							Sinusoidals of long period and small amplitude on both components recurring constantly during the day.
11	....	L_E	2 10 ..					Wavelets — thickening of pen-marks.
		F_E	3 20 ..					
16-17	....							Visible activity at intervals during the day.

TABLE 2.—*Instrumental reports, April, 1918*—Continued.

Colorado. *Denver*—Continued.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Apr. 21		P_N						Not discernible.
		P_E	22 34 ..					
		S_N	22 34 ..					
		S_E	22 36 ..					
		L_N	22 38 ..	5		{*22,000 25,000}		
		L_E	22 38 ..	5	*25,000			
		M_E	22 37 ..	4–6	*66,000			
		M_N	22 38 ..	4–6		*56,000		
		C_N	22 40 ..	*8		{*2,000 8,000}		
		C_E	22 44 ..	7	{*2,000 8,000}			
		F	22 54 ..					
22		L_N	22 40 ..					Broken waves visible—strong activity.
		F_N	23 33 ..					
23–24								Long-period waves at intervals during the day.
30								Activity and wavelets at intervals during the day.

District of Columbia. *Washington. Georgetown University.* F. A. Tondorf, S. J.

Lat., 38° 54′ 25″ N.; long., 77° 04′ 24″ W Elevation, 42.4 meters. Subsoil: Decayed diorite.

Instruments: Wierchert 200 kg. astatic horizontal pendulums, 80 kg. vertical.

Instrumental constants..		*V*	T_0	ε
	E	165	5.4	0
	N	143	5.2	0
	Z	*80*	*3.0*	*0*

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Apr. 10		i	1 09 12					'Quake felt locally. F in heavy wind markings.
		M_N	1 09 29	¼		*1,800		
		M_E	1 09 32	¼	*2,000			
		F	1 13 28					
			VERTICAL.			A_z.		
		i	*1 09 13*					
		M_z	*1 09 34*	*2*		**1,600*		
		F	*1 13 39*					
10		S_E?	2 25 31					Earlier part of 'quake lost in changing of sheets. Heavy microseisms.
		S_N?	2 25 50					
		F	3 10 ..					
15		iP	8 36 49					Microseisms present.
		S	8 44 00					
		eL_N?	8 50 06	11				
		eL_E?	8 50 24	11				
		M_N	8 53 42			*200		
		M_E	8 53 45		*300			
		F	9 11 ..					
17		e	6 57 40					Heavy microseisms.
		L	7 03 24	15				
		F	7 15 ..					
			VERTICAL.					
19		e_z	*15 55 58*					Disturbance felt locally, doubtful as to seismic origin.
		F_z	*16 04 ..*					
21		P_N	22 38 57					Mainka shows: P_E 22h39m02s. P_N 22h39m09s. S_E 22h44m19s. S_N 22h44m36s.
		iP_E	22 39 04					
		S_N	22 44 25					
		S_E	22 44 31					
		eL	22 47 48					
		M_{N1}	22 49 42	4		*42,500		
		M_{E1}	22 49 50	5.5	*16,000			
		M_{N2}	22 52 13	8		*10,500		
		M_{E2}	22 53 43	5	*20,000			
22		F	0 40 ..					
			VERTICAL.			A_z		
21		P_z	*22 39 02*					
		S_z	*22 44 38*					
		eL_z	*22 47 42*					
		M_z	*22 49 31*	*5*		**13,000*		
		F_z	*22 50 ..*					
27		S?	14 57 25					P difficult, lost in heavy microseisms.
		eL_E	15 01 12	16				
		eL_N	15 01 30	16				
		F	15 25 ..					

* Trace amplitude.

District of Columbia. *Washington. U. S. Weather Bureau.*

Lat., 38° 54′ 12″ N.; long., 77° 03′ 03″ W. Elevation, 21 meters.

Instrument: Marvin (vertical pendulum), undamped. Mechanical registration.

Instrumental constants..	*V*	T_0
	110	6.4

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Apr. 10		P	1 09 12?				100	Virginia earthquake. Timing clock stopped, time estimated.
		S?	1 09 22?					
		M	1 09 34?		*3,000			
		F	1 12 ..					
15		P	8 36 49					F lost in microseisms.
		S	8 44 01					
		L?	8 49 30					
		F	9 20 ..					
21		eP	22 39 01				3,600	San Jacinto, Cal.
		eS	22 44 25					
		L?	22 48 ..					
		M_N	22 50 ..			*90,000		Trace ran off the sheet.
		M_E	22 53 ..		*65,000			
		F	24					
27		eL	15 01 50					Heavy microseisms.
		F	15 06 ..					

*Trace amplitude.

Hawaii. *Honolulu. Magnetic Observatory.* U. S. Coast and Geodetic Survey. Frank Neumann.

Lat., 21° 19′ 12″ N.; long., 158° 03′ 48″ W. Elevation, 15.2 meters.

Instrument: Milne seismograph of the Seismological Committee of the British Association.

Instrumental constant..	T_0
	18.6

(No earthquake recorded during April, 1918.)

Kansas. *Lawrence. University of Kansas.* Department of Physics and Astronomy. F. E. Kester.

Lat., 38° 57′ 30″ N.; long., 95° 14′ 58″ W. Elevation, 301.1 meters.

Instrument: Wiechert.

Instrumental constants..		*V*	T_0	ε
	E	177	3.4	4:1
	N	205	3.4	4:1

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ Trace	*km.*	
Apr. 10		P	2 15 47					
		iP	2 15 48		0.4	0.4		
		eS?	2 18 35					
		L	2 25 18					
		M_E	2 25 46		3.4			
		M_N	2 25 48			0.9		
		F_E	2 45 ..					
		F_N	2 51 ..					
17		eP_E	6 47 57					
		eP_N	6 48 00					
		eS_E	6 52 02					
		eS_N	6 52 09					
		L_N	6 55 24					
		M_N	6 56 25					
		L_E?	6 56 55					
		M_E	6 58 53					
		F_E	7 05 ..					
		F_N	7 13 ..					
21		iP_E	22 36 38					P_N 5 seconds later evidently reaction from E–W component. S_E not discernible.
		S_N?	22 39 43					
		S_N	22 40 04					
		L	22 41 34					
		L_N?	22 41 58					
		L_E?	22 41 59					
		M_N	22 42 21			103.2		
		M_E	22 43 48		102.3			
		F_N	23 55 ..					

TABLE 2.—*Instrumental reports, April, 1918*—Continued.

Maryland. *Cheltenham. Magnetic Observatory.* U. S. Coast and Geodetic Survey. George Hartnell.

Lat., 38° 44′ 00″ N.; long., 76° 50′ 30″ W. Elevation, 71.6 meters.

Instruments: Two Bosch-Omori, 10 and 12 kg.

Instrumental constants.. E: V 10, T_0 15; N: V 10, T_0 15

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Apr. 10	..•.....	P.....	1 09 12					Reported as felt at Cheltenham and Croome, Md. Principal portion recorded on magnetograph.
		L.....	1 09 30					
		M_E....	1 09 32	2	50			
		M_N....	1 09 36	2		50		
		F.....	1 18 ..					
21	....	eP_N...	22 39 12					E stylus not recording.
		S_N....	22 44 29					
		eL_N...	22 47 20	14				
		M_N....	22 50 28	14		2,400		
		C.....	22 55 ..					
		F.....	23 49 ..					

Massachusetts. *Cambridge. Harvard University Seismographic Station.* J. B. Woodworth.

Lat., 42° 22′ 36″ N.; long., 71° 06′ 59″ W. Elevation, 5.4 meters. Foundation: Glacial sand over clay.

Instruments: Two Bosch-Omori 100 kg. horizontal pendulums (mechanical registration).

Instrumental constants.. E: V 80, T_0 23, ϵ 0; N: V 50, T_0 25, ϵ 4:1

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Apr. 21...	....	O.....	22 32 24				4,040	N component out of commission for repairs. Undamped pendulum. A increases as T shortens. Stylus left drum for 1m. 11s. Trace amplitude, 65 mm. Origin, southern California.
		iP_E...	22 39 45					
		S_E....	22 45 34					
		eL_E...	22 49 08	12				
		L_E....	22 51 34	6				
		M_E....	22 55 00	15				
22		F.....	0 48 27					

Missouri. *Saint Louis. St. Louis University.* Geophysical Observatory. J. B. Goesse, S. J.

Lat., 38° 38′ 15″ N.; long., 90° 13′ 58″ W. Elevation, 160.4 meters. Foundation: 12 feet of tough clay over limestone of Mississippi system, about 300 feet thick.

Instrument: Wiechert 80 kg. astatic, horizontal pendulum.

Instrumental constants.. V 80, T_0 7, ϵ 5:1

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Apr. 17...	Ir.....	P_N?...						P on both components not recorded. No S on E-W. S on N-S doubtful.
		iS_N...	6 55 54					
		eL_N...	6 57 42	21		*2,000		
		eL_E...	6 57 42	12	*1,000			
21	IIIr...	iP.....	22 37 24				2,657	San Jacinto, Cal.
		S.....	22 41 36					
		L.....	22 43 12					
		M_E....	22 45 06	6	*70,000			
		M_N...	22 45 06	12		*45,000		
		F_E....	23 28 00					
		F_N....	23 53 00					
22	....	....	....	....	....	....	......	Isolated shocks.
23	....	....	....	....	....	....	......	Isolated shocks.

* Trace amplitude.

New York. *Buffalo. Canisius College.* John A. Curtin, S. J.

Lat., 42° 53′ 02″ N.; long., 78° 52′ 40″ W. Elevation, 190.5 meters.

Instrument: Wiechert 80 kg. horizontal.

Instrumental constants.. V 80, T_0 7, ϵ 5:1

(Report for April, 1918, not received.)

New York. *Fordham. Fordham University.* Daniel H. Sullivan, S. J.

Lat., 40° 51′ 47″ N.; long., 73° 53′ 08″ W. Elevation, 29.3 meters.

Instrument: Wiechert, 80 kg.

Instrumental constants.. E: V 72, T_0 5.0, ϵ 0; N: V 72, T_0 5.0, ϵ 0

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Apr. 21...	....	iP_E...	23 34 55					
		P_N....	23 34 59					
		iS_E....	23 40 28					
		iS_N...	23 40 31					
		L_E....	23 44 07					
		L_N....	23 44 19					
		M_E....	23 46 28	4.5	*36,000			Great amplitudes due to resonance.
		M_N...	23 47 03	4.5		*53,000		
		C.....	23 56 00					
22		F.....	0 27 00					

*Trace amplitude.

New York. *Ithaca. Cornell University.* Heinrich Ries.

Lat., 42° 26′ 58″ N.; long., 76° 29′ 09″ W. Elevation, 242.6 meters.

Instruments: Two Bosch-Omori, 25 kg., horizontal pendulums (mechanical registration).

Instrumental constants.. E: V 13, T_0 22, ϵ 4:1; N: V 14, T_0 25, ϵ 4:1

(Report for April, 1918, not received.)

Panama Canal. *Balboa Heights.* Governor, Panama Canal.

Lat., 8° 57′ 39″ N.; long., 79° 33′ 29″ W. Elevation, 27.6 meters.

Instruments: Two Bosch-Omori, 100 kg.

Instrumental constants.. V 35, T_0 20

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Apr. 21	....	....	....	....	....	....	......	Slight tremors from 22^h 40^m to 23^h 20^m. Distance and direction unknown.
25	....	....	....	....	....	....	......	Slight tremor 3^h 15^m 00^s. Distance and direction unknown.
25	....	P_E....	21 47 48				280	Direction?
		P_N....	21 47 51					
		L_E....	21 48 22	20				
		L_N....	21 48 25	20				
		M_E....	21 48 32		*3,000			
		M_N....	21 48 33			*2,000		
		F_E....	21 57 ..					
		F_N....	21 59 ..					

*Trace amplitude.

Porto Rico. *Vieques. Magnetic Observatory.* U. S. Coast and Geodetic Survey. F. L. Adams.

Lat., 18° 09′ N.; long., 65° 27′ W. Elevation, 19.8 meters.

Instruments: Two Bosch-Omori.

Instrumental constants.. E: V 10, T_0 17.5; N: V 10, T_0 18.2

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Apr. 21	....	eP_E...	22 41 17					
		eP_N...	22 43 12					
		eL_N...	23 00 40	26				
		eL_E...	23 01 20	14				
		M_N....	23 03 57	16		40		
		M_E....	23 09 06	14	40			
		C.....	23 12 ..	12				
		F.....	23 50 ..	10				
22	....	e_N....	4 15 50					
		e_E....	4 15 52					
		M_N....	4 15 57	2		40		
		M_E....	4 16 02	4	40			
		F.....	4 21 ..					

TABLE 2.—*Instrumental reports, April, 1918*—Continued.

Vermont. *Northfield. U. S. Weather Bureau.* Wm. A. Shaw.

Lat., 44° 10′ N.; long., 72° 41′ W. Elevation, 256 meters.

Instruments: Two Bosch-Omori, mechanical registration.

Instrumental constants.. $\begin{cases} E & 10 & 15 \\ N & 10 & 16 \end{cases}$ (V, T_0)

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Apr. 17		e_N	7 01 35					
		L_N	7 04 40	12				
		F_N	7 08 ..					
21		P	22 39 13				3,500	San Jacinto, Cal.
		S	22 44 30					
		L	22 48 10					
		M_E	22 54 ..		*15,000			
		M_N	22 52 30			*43,000		
		F	23 40 ..					

*Trace amplitude.

Canada. *Ottawa. Dominion Astronomical Observatory.* Earthquake Station. Otto Klotz.

Lat., 45° 23′ 38″ N.; long., 75° 42′ 57″ W. Elevation, 83 meters.

Instruments: Two Bosch photographic horizontal pendulums, one Spindler & Hoyer 80k. vertical seismograph.

Instrumental constants.. 120 26 (V, T_0)

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Apr. 10		e_N	1 12 27					
			1 14 ..	2.5				Both pendulums have been set to register N-S during the month.
10		e_N	2 15 47	3				
		e_N	2 25 17	1.5				
		e_N	2 25 42	2.5				
		e_N	2 26 48	4				
		eL_N	2 28 30†	8				
		L_N	2 31 ..	8				
		L_N	2 40 ..	8				
		L_N	2 45 ..	8				
		F	2 50 ..					
13		eL_N	2 08 to 2 15 ..	20				
		L_N	2 18 ..	18				
		F	2 30 ..					
15		*O*	*8 27 44*				5,050	
		P_N	8 36 15					
		$P_{N rep l.}$	8 38 08					
		S_N	8 43 00					
		L_N	8 49 36†	12				
		M_N	8 53 ..	12		60		
		L_N	8 57 ..	8				
		F	9 15 ..					
17		e_N	3 04 ..					
		eL_N	{ 3 08 .. 3 17 ..	15				
		F	3 20 ..					
17		eL_N	7 01 ..					
		L_N	7 03 ..	15				
		L_N	7 08 ..	8				
		F	7 20 ..					
21		*O*	*22 32 24*				3,600	
		eP_N	22 39 12					
		S_N	22 44 36					
		$S_{N rep l.}$	22 46 14					
		eL_N	22 48 12†					
		M_N	22 51 ..	12		1,000		
		L_N	23 05 ..	12				
		L_N	23 12 ..	12				
		L_N	23 20 ..	9				
		L_N	23 34 ..	12				
		F	24					
27		*O?*	*14 43 50*				4,100?	
		eP_N?	14 51 15					
		eS_N?	14 57 08					
		$S_{N rep l}$	15 59 24					
		eL_N	15 02 ..					
		L_N	15 05 ..	16				
		L_N	15 10 ..	11				
		F	15 20 ..					

† Original time given in tenths of a minute.

Canada. *Toronto. Dominion Meteorological Service.*

Lat., 43° 40′ 01″ N.; long., 79° 23′ 54″ W. Elevation, 113.7 meters. Subsoil: Sand and clay.

Instrument: Milne horizontal pendulum, North. In the meridian.

Instrumental constant.. T_0 18. Pillar deviation, 1 mm. swing of boom=0.50″.

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Apr. 10		L	2 25 48†					
		L	2 29 42					
		M?	2 29 54		*300			
		L	2 38 48					
		F	2 57 42					
13		L	2 07 18					
		L_E	2 16 48					
		M?	2 21 18		*200			
		L_E	2 48 48?					
		F	2 54 48					
15		L	8 47 06					
		L	8 53 06		*50			
		F	9 04 54					
17		eL	3 06 54					
		L	3 09 54					
		L	3 21 12		*200			
		F	3 30 06					
17		P?	6 47 54					
		L_E	6 58 00					
		iL	7 04 24					
		M	7 04 54		*300			
		F	7 17 54?					
20		L	6 59 00					
		L_E	7 00 24					
		M	7 01 24		*200			
		F	7 19 12?					
21		P	22 39 06				3,520	San Jacinto, Cal. Clear record, but P waves not well defined.
		S_E	22 44 24					
		iS	22 45 42					
		L	22 49 48					
		iL	22 51 36					
		M	22 51 54		*10,000			
		iL	23 09 12					
22		F	1 21 12					
27		L_E	15 02 06					
		M	15 07 48		*300			
		F	15 34 36?					

* Trace amplitude. † Original time for all readings given in tenths of a minute.

Canada. *Victoria, B. C. Dominion Meteorological Service.*

Lat., 48° 24′ N.; long., 123° 19′ W. Elevation, 67.7 meters. Subsoil: Rock.

Instrument: Wiechert, vertical; Milne horizontal pendulum, North. In the meridian.

Instrumental constant.. T_0 18. Pillar deviation, 1 mm., swing of boom=0.54″.

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Apr. 10		P?	2 21 24					
		M	2 22 21		*200			
		L?	2 57 46					
13		L	2 10 36		*50			
15		P	8 31 51				2,410	Well-defined disturbance.
		L	8 35 49					
		M	8 37 48		*500			
		F	8 46 44					
			VERTICAL.			A_z.		
		P	*8 32 28*	*2-3*			*2,410*	
		L	*8 36 26*	*6*				
		M	*8 37 24*	*7-8*		*7*		
		F	?					
15		M	19 34 57		*50			Thickening.
17		P	2 48 33				550?	
		L	2 ? ?					
		M	2 49 33		*100			
		F	2 55 30					
17		P	6 46 06				1,110	
		L	6 48 05					
		M	6 48 34		*1,000			
		F	6 58 29					
			VERTICAL.			A_z.		
		P	*6 46 40*	*2-3*			*550?*	
		L	*6 47 40?*	*6*				
		M	*6 48 00*	*7-8*		*10*		

* Trace amplitude.

TABLE 2.—*Instrumental reports, April, 1918*—Continued.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
			Canada. *Victoria, B. C.*—Continued.					
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Apr. 20		L	7 11 12		*50			
		F	7 15 30					
21		P	22 35 57				1,770	San Jacinto, Cal.
		S	22 39 09					
		L	22 40 37					
		M	22 43 25		*29,000			
22		F	0 35 33					
			VERTICAL.			A_z.		
		P	*22 36 16*	*3*			*1,710*	
		S	*22 39 13*	*10–12*				
		L	*22 41 17*	*12–14*				
		M	*22 43 54*	*18*		*36*		
		F	*23 34 07*					
27		P or S.	15 07 18					
		L	15 09 32					
		M	15 11 46		*500			
		F	15 18 42					

* Trace amplitude.

SEISMOLOGICAL DISPATCHES.[1]

Washington, D. C., April 9, 1918.
A slight earthquake shock was felt here at 9hrs. 9m. 12s. p. m. In the neighborhood of the Georgetown University Seismic Station windows were broken. The tremors lasted for about three minutes. (Georgetown University Station.)

Richmond, Va., April 9, 1918.
Several residents of Highland Park reported to the police and the newspapers to-night that their homes were severely shaken for several seconds. Three distinct shocks were felt. (Assoc. Pr.)

Lynchburg, Va., April 9, 1918.
A pronounced earthquake shock, continuing for a little less than one minute, was felt here to-night shortly after 9 o'clock, causing many inquiries at the local newspapers. It was felt also in the contiguous counties. No damage. (Assoc. Pr.)

[1] Reported by the organization indicated and collected by the seismological station at Georgetown University, Washington, D. C.

Woodstock, Md., April 9, 1918.
Slight earthquakes were felt here at a few minutes past 9 o'clock p. m. (Local observer.)

Luray, Va., April 16, 1918.
Northern Virginia felt the fifth earthquake shock within a week. The shock came at 8:40 a. m. Buildings rocked, windows rattled, and consternation reigned. (Assoc. Pr.)

[This 'quake was not recorded on seismographs at Washington, D. C.]

Eureka, Cal., April 17, 1918.
An earthquake, said to have been the most severe experienced here in a decade, occurred last night. The vibrations lasted 30 seconds. No damage. (Assoc. Pr.)

Fort de France, Martinique, April 19, 1918.
Slight earthquake shocks have been felt here for five days. The tremors began soon after noon Sunday, 14th, and continued until 2 o'clock this afternoon. (Assoc. Pr.)

Norfolk, Va., April 19, 1918.
Two distinct earthquake shocks were felt here and at Suffolk shortly before noon to-day. (Assoc. Pr.)

Los Angeles, Cal., April 21, 1918.
All of southern California and part of western Arizona and Utah were shaken to-day at 3:32 p. m. by an earthquake, which wrecked virtually all buildings and residences in Hemet and San Jacinto, two inland towns 45 miles southeast of Riverside, Cal., and caused minor property damage in practically every town and city in this section of the State. (Assoc. Pr.)

San Jacinto, Cal., April 23, 1918.
Three more shocks occurred in this place, one at midnight, one at 2 a. m., the third at 7:15 a. m. The last of these three was the more severe. Windows rattled and dishes were shaken. (Assoc. Pr.)

San Jacinto, Cal., April 25, 1918.
Two more earthquake shocks occurred during the night, one at 8 o'clock and the other at midnight. No damage was done. (Assoc. Pr.)

Rome, April 25, 1918.
Earthquake shocks lasting a minute were felt at Milan and Bergam, in northern Italy. No damage was done. (Assoc. Pr.)

San Jacinto, April 27, 1918.
One of the most severe of a score of earthquakes occurred last night at about 10:30. No damage was done. (Assoc. Pr.)

SECTION VI.—BIBLIOGRAPHY.

RECENT ADDITIONS TO THE WEATHER BUREAU LIBRARY.

C. Fitzhugh Talman, Professor in Charge of Library.

The following have been selected from among the titles of books recently received as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies:

Alaska. Agricultural experiment stations.
Report of the Alaska agricultural experiment stations. 1916 . . . Washington. 1918. 91p. plates. fold. map. tables. 23cm. [Climatological data, p. 81–91.]

Bigelow, Frank H[agar].
A treatise on the sun's radiation and other solar phenomena, in continuation of the Meteorological treatise on atmospheric circulation and radiation. 1915. New York. 1918. ix, 385 p. incl. charts. tables. 23½ cm.

Canada. Meteorological service.
Report for the year ended December 31, 1915 . . . Ottawa. 1917. xv, 666 p. incl. tables. 30 cm. At head of title: Department of marine and fisheries.

Colton, Harold Sellers.
The geography of certain ruins near the San Francisco mountains, Arizona. plates, maps (part. fold.) chart. tables. 25 cm. (From Bulletin of the Geographical society of Philadelphia. v. 16, no. 2. April, 1918. p. 1–24.) [Discusses the ruins as affording evidence of climatic oscillations.]

Flora, S[nowden] D[wight].
Some common fallacies about Kansas weather. (Excerpted from Missouri journal of education, Kansas City, Mo. vol. 2, no. 21. April 20, 1918. p. 8–11.) 30 cm.

Frazier, Rex Dunbar.
The Galveston hurricane of nineteen fifteen. cover-title, 19 p. 26 cm. (Reprinted from Stone & Webster. Public service journal, Oct. 1915.)

Great Britain. Meteorological office.
Meteorological glossary (Fourth issue) in continuation of The weather map, (M. O. 225 i,). London. 1918. 358 p. plates. charts (part. fold.) tables. 15½ cm. M. O. 225 ii.
Monthly meteorological charts of the Mediterranean basin. January-December. London. [1918] 12 charts. 44½ x 57½ cm. M. O. 224 (2d edition.)

Japan. Central meteorological observatory.
On the barometric depressions in the year 1902, 1903, 1905–1907, 1909, 1911. Tokio. 1917–18. 7 v. charts. 29½ cm. At head of title: Annual report . . . Part 2.
The cyclonic storms in the year 1912–1917. Tokio. 1918. 6 v. charts. 29½ cm. At head of title: Annual report . . . 1912–1917.

Neill, W. T.
Extracts from a paper on atmospheric refraction. [Read before the astronomical branch, Otago institute, N. Z., 26th Oct. 1915.] tables. diagrs. 30½ cm. (The astronomical journal, Albany, N. Y. vol. 31, no. 2. Nov. 26, 1918. p. 9–16.)

Smith, J[oseph] Russell.
Origin of civilization through intermittency of climatic factors. (From Bulletin of the Geographical society of Philadelphia. v. 16, no. 2. April, 1918. p. [25]–29.) 25 cm.

U. S. National advisory committee for aeronautics.
Third annual report. 1917. Washington. 1918. 495 p. plates. charts. tables. diagrs. (part. fold.) 26 cm. [Report no. 13. Meteorology and aeronautics, by W. R. Blair, p. 35–82.]

U. S. Navy dept.
A manual of aerography for the United States navy. 1918. Washington. 1918. 165 p. incl. tables. 23½ cm. "Compiled and edited under the supervision of Lieut. Commander Alexander McAdie, U. S. R. F." Bibliography, p. 163–165.

Winberg, O. F. E.
Report on freeze injury to citrus trees for 1916 and 1917, with notes on orange culture in south Alabama, by O. F. E. Winberg and G. C. Starcher, assisted by C. L. Isbell. Opelika, Ala. 1918. 26 p. illus. 2 maps. 23½ cm. At head of title: Alabama agricultural experiment station of the Alabama polytechnic institute, Auburn. Bulletin no. 199. March, 1918.

63385—18——3

RECENT PAPERS BEARING ON METEOROLOGY AND SEISMOLOGY.

C. Fitzhugh Talman, Professor in Charge of Library.

The following titles have been selected from the contents of the periodicals and serials recently received in the Library of the Weather Bureau. The titles selected are of papers and other communications bearing on meteorology and cognate branches of science. This is not a complete index of all the journals from which it has been compiled. It shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau.

Franklin Institute. Journal. Philadelphia. v. 185. May, 1918.
Humphreys, W[illiam] J[ackson]. Physics of the air. p. 611–647. (Continuation.)

National academy of sciences. Proceedings. Baltimore. v. 4. April, 1918.
Abbot, C[harles] G[reeley.] Terrestrial temperature and atmospheric absorption. p. 104–106.

Nature. London. v. 101. April 18, 1918.
Dale, J. B. Elliptical haloes. p. 126. [See above p. 166.]

Physical society of London. Proceedings. London. v. 30 pt. 2. February 15, 1918.
Boys, C. V[ernon.] Recording thermometer. p. 94–99.

Royal meteorological society. Quarterly journal. v. 44. April, 1918.
Lyons, H. G. Presidential address, annual general meeting. (The meteorological resources of the empire.) p. 69–89.
Bellamy, F. A. On the barometer record at the Radcliffe observatory, Oxford, with special reference to Professor Turner's suggested discontinuities. p. 91–97.
Chree, C[harles]. The diurnal variation of barometric pressure at seven British observatories, 1871–1882. A correction and some additions. p. 99–111.
Barnes, Alfred A. Diagram illustrating discontinuities in rainfall at 28 stations. p. 128–130.
Dines, J. S. The rate of ascent of pilot balloons. p. 131–133.
Brooks, C. E. P. The meteorology of Zomba, Nyassaland, 133–136.

Royal society. Proceedings. London. ser. A. v. 94. no. 660. 1918.
Aitken, John. Revolving fluid in the atmosphere. p. 250–259.
Strutt, R. J. Ultra-violet transparency of the lower atmosphere, and its relative poverty in ozone. p. 260–268.

Science. New York. v. 47. April 26, 1918.
Von Herrmann, C. F. The desiccation of the earth. p. 417. [Part played by lightning, through decomposing water vapor.]

Scientific American supplement. New York. v. 85. 1918.
Patterson, J. The energy required to produce rain. p. 279. (May 4.) [Repr. from Roy. astron. soc., Canada.]
Wood, Frank S. Long range temperature forecasts, a method of comparing weather records with a view to predicting future conditions. p. 318–320. (May 18.)

Seismological society of America. Bulletin. Stanford university. v. 8. March, 1918.
Palmer, Andrew H. California earthquakes during 1917. p. 1–12. [Compare p. 180, above.]
Mulholland, W[illiam.] Earthquakes in their relation to the Los Angeles aqueduct. p. 14–19.
Hamlin, Homer. Earthquakes in southern California. p. 20–24.
Staunton, W. F. Effects of an earthquake in a mine at Tombstone, Arizona. p. 25–27.
Wood, Harry O. The study of earthquakes in southern California. p. 29–33.
Reid, Harry Fielding. Note on the velocity of long waves and the average depth of the ocean. p. 34–37.

Symon's meteorological magazine. London. v. 53. April, 1918.
Sec. Lieut. Donald Sowerby Salter, R. G. A. March 16th, 1890–March 22, 1918. p. 25–26. [Obituary.]
Bonacina, L. C. W. Inverse weather phenomena. p. 30–32.

Académie des sciences. Comptes rendus. Paris. Tome 166. 15 avril 1918.
Perrotin, H. Sur le refroidissement nocturne des couches basses de l'atmosphère. p. 616–617.

Archives des sciences physiques et naturelles. Genève. 4 pér. v. 45. Mars 1918.
Saussure, Réné de. Projet de bureau météorographique européen 2 note. p. 178–190.

SECTION VII.—WEATHER AND DATA FOR THE MONTH.

THE WEATHER OF APRIL, 1918.

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PRESSURE AND WINDS.

The distribution of the mean atmospheric pressure over the United States and Canada, and the prevailing direction of the winds for April, 1918, are graphically shown on Chart VII, while the means at the several stations, with the departures from the normal, are shown in Tables I and III.

April opened with pressure below the normal throughout the country, except on the extreme northern Pacific coast where it was slightly above. Low pressure continued in most districts for several days, except that an area of higher barometer moved in from the far Northwest and gradually overspread the more northern and eastern sections, so that by the middle of the first decade the pressure was generally high from the Mississippi River eastward. Lower pressure followed for a few days, particularly in the more southern districts, after which there was a change to higher pressure in most northern and eastern districts. This continued until near the middle of the month, while in the far Southwest the pressure remained relatively low throughout much of the period. During the second half of the month an occasional HIGH area moved across the Northern and Central States, otherwise pressure was generally below the normal and especially in the more southern districts. The month closed with high pressure in the far Northeast, also from the Mississippi River to the Rocky Mountains and along the northern Pacific coast; elsewhere pressure was generally below the seasonal average.

For the month as a whole the barometric pressure averaged above the normal throughout the northern half of the country, and over the extreme eastern and western portions of Canada. Over all southern districts the average pressure for the month was below the normal, as also in the central districts of Canada. In the middle Plains Region, the far Northwest, over much of New England and the Canadian Maritime Provinces, the positive departures approached 0.10 inch; and the negative departures in the extreme South were nearly as large.

The distribution of the HIGHS and LOWS favored northerly winds in the upper Missouri Valley, the Lakes Region, the Ohio and central Mississippi Valleys, New England, portions of the Middle and South Atlantic States, and along the Pacific coast. In the Gulf States and over much of the southern Plains Region the winds were mostly from southerly points.

TEMPERATURE.

At the beginning of the month generally high temperature for the season prevailed in the East and South, but after a few days decidedly colder weather moved from the Canadian Northwest into practically all eastern and southeastern districts. A gradual warming up followed, but toward the end of the first decade a marked drop in temperature occurred in the upper Lakes Region. A further fall in temperature occurred in most eastern districts during the early part of the second decade, but at the same time there was a considerable warming up in the Rocky Mountains Region and northern Plains States. The temperature continued unusually low in most sections east of the Mississippi until near the middle of the decade, when generally warmer weather set in and continued for several days; but toward the latter part of the decade a sharp drop brought temperatures to considerably below the seasonal average in the South. The next few days gave rather low temperature for the season from the Ohio Valley and Lakes Region eastward and west of the Rocky Mountains, but in most southern districts temperatures were near the seasonal average. About the middle of the last decade colder weather moved in over the Rocky Mountains Region, extended to the Missouri and Mississippi Valleys, and eastward during the next several days. The month closed with somewhat lower temperature over the Great Plains and with sea sonable temperature west of the Rocky Mountains.

For April as a whole temperature was slightly above the normal along the Atlantic and Pacific seaboards, in the far Southwest, and generally along the Canadian border from the Great Lakes westward. Over the interior the monthly means were everywhere below the normal, the deficiencies ranging from 3 to 6 degrees per day from the Ohio Valley westward to the middle Plateau Region.

PRECIPITATION.

The month opened with cloudy, unsettled weather in most eastern districts, and during the first few days considerable rain fell in the central and northern Rocky Mountains districts and also from the Mississippi Valley eastward, the fall being rather large in portions of the Ohio Valley and central and east Gulf States. Fair weather followed in practically all eastern sections until shortly after the middle of the first decade, when heavy rains occurred in portions of Texas, Louisiana, and Arkansas, and there were general and beneficial rains over most of the Plains States, extending eastward during the following few days, with some heavy falls in portions of the Gulf and South Atlantic States.

Early in the second decade heavy rains occurred in Pennsylvania, Maryland, and Virginia, and snow fell in the central and northern Appalachian districts, in Ohio and Kentucky and to the northeastward. About the middle of the decade a rain area moved over most of the Plains Region from Texas northward, and also over the Rocky Mountains district. The falls were rather heavy in Texas, Oklahoma, and Arkansas, and generous in the western portions of Kansas and Nebraska, where moisture was needed. Unsettled, showery weather continued in most eastern sections during the remainder of the decade, while west of the Rocky Mountains generally fair weather prevailed.

Widespread rains fell in most eastern districts during the first few days of the third decade, and shortly after its middle heavy rain fell in Texas and southern Louisiana, while snow occurred in the western portions of Nebraska and South Dakota and in Wyoming and Colorado. This general precipitation area moved over the Plains States and to the eastward—except portions of the Atlantic Coast States—with rather large falls in parts of the Florida Peninsula, the central Gulf States, the middle Mississippi Valley, and locally in the northern Great Plains Region. The month closed with rain in portions of the Gulf States and also in the lower Lakes Region and with snow in northern Michigan.

For April as a whole precipitation was heavy to excessive in much of the South Atlantic and Gulf States, and the central and southern portions of the Mississippi Valley, while in most other sections east of the Rocky Mountains it was generally near the normal, except in the southern Plains States, where the fall was as a rule below the seasonal average. In the Rocky Mountains Region and westward the precipitation was generally considerably below the normal, with little or no rain in extreme southwestern Texas and the southern portions of California, Arizona, and New Mexico.

RELATIVE HUMIDITY.

In general the relative humidity conformed to the temperature conditions, and there was a very general increase above the normal in the regions with negative temperature departures. The excess was particularly marked over the southeastern States and in the central Plains Region. From the Dakotas and Nebraska eastward the relative humidity was generally below the normal, and a well-marked deficiency was also observed over the Pacific Coast States.

GENERAL SUMMARY.

Farm work made good progress during the first decade but throughout the remainder of the month was somewhat retarded by frequent rains in most central and eastern districts. The weather of this April was generally too cold and wet for satisfactory progress of corn and cotton, and in a few sections these crops were considerably damaged. On the other hand, cool and moist weather favored winter wheat, and that crop made excellent progress almost everywhere. Other grain crops were likewise benefited. Some early truck crops were damaged in exposed sections by the low temperature, yet as a whole they made good progress during the month.

Meadows and pastures progressed favorably except in the far Southwest, where damage resulted from lack of moisture. Live stock was generally in good condition, although some losses of unprotected young stock occurred in the northern Rocky Mountains district.[1] Frosts and low temperature injured early fruits in portions of the southern Appalachian Region, the Ohio and lower Missouri Valleys, and in the Rocky Mountain and Pacific Coast States, and peaches were found to be badly winter-killed from the central Mississippi Valley northeastward. However, as a whole, the general outlook for fruit at the end of the month was good.

[1] Compare report on stock-warnings by San Francisco forecast district, above, p. 184.

Average accumulated departures for April, 1918.

Districts.	Temperature.			Precipitation.			Cloudiness.		Relative humidity.	
	General mean for the current month.	Departure for the current month.	Accumulated departure since Jan. 1.	General mean for the current month.	Departure for the current month.	Accumulated departure since Jan. 1.	General mean for the current month.	Departure from the normal.	General mean for the current month.	Departure from the normal.
	° F.	° F.	° F.	In.	In.	In.	0-10.		P. ct.	
New England	44.2	+0.6	− 9.8	2.97	0.00	−3.40	5.4	−0.2	72	−2
Middle Atlantic	50.6	−0.1	− 3.7	4.63	+1.60	−0.50	6.5	+1.2	72	+4
South Atlantic	60.5	−0.8	+ 2.3	5.35	+1.90	−4.20	6.1	+1.9	77	+6
Florida Peninsula	73.8	+0.2	+ 4.3	3.06	+1.10	−2.20	3.4	−0.3	73	−1
East Gulf	62.7	−2.0	+ 3.8	8.32	+4.20	−2.00	6.4	+1.4	76	+4
West Gulf	64.4	−1.4	− 1.0	5.89	+2.40	−2.30	5.3	+0.2	72	−1
Ohio Valley and Tennessee	52.6	−2.0	− 5.4	4.15	+0.60	−2.20	7.0	+1.6	70	+4
Lower Lakes	44.6	−0.5	− 6.7	2.25	−0.10	−0.40	6.1	+0.3	68	−3
Upper Lakes	39.9	−1.1	− 6.9	2.21	−0.20	0.00	5.2	−0.5	69	−2
North Dakota	42.2	+1.5	+15.6	2.46	+0.60	−0.20	5.0	−0.2	63	−4
Upper Mississippi Valley	46.4	−4.1	− 3.8	3.17	+0.20	−2.00	5.7	+0.4	67	−1
Missouri Valley	47.0	−3.4	+ 2.7	2.90	0.00	−1.00	5.5	+0.2	62	−2
Northern slope	39.7	−3.1	+ 4.2	1.86	+0.30	+0.10	6.4	+1.3	66	+6
Middle slope	48.4	−5.3	− 0.9	3.50	+0.30	+0.40	5.6	+0.9	64	+6
Southern slope	61.5	−0.9	+ 5.1	0.55	−0.10	−1.30	3.8	−0.6	45	−8
Southern Plateau	60.5	−0.5	+ 1.4	0.13	−0.20	0.00	2.4	−0.4	34	0
Middle Plateau	46.8	−2.1	+ 1.2	0.34	−0.80	−0.60	3.9	−0.2	46	−2
Northern Plateau	48.4	−0.6	+ 9.3	0.50	−0.80	−1.10	4.5	−0.8	49	−7
North Pacific	49.9	+0.8	+ 5.7	1.20	−2.10	0.00	4.8	−1.4	72	−4
Middle Pacific	55.3	+1.7	+ 3.4	0.83	−1.20	−4.90	2.7	−1.5	62	−8
South Pacific	60.5	+2.4	+ 7.7	0.05	−1.00	+2.90	3.5	−0.3	63	−6

WEATHER CONDITIONS OVER THE NORTH ATLANTIC OCEAN DURING APRIL, 1917.

The data presented are for April, 1917, and comparison and study of the same should be in connection with those appearing in the REVIEW for that month.

Chart IX (XLVI—39) shows for April, 1917, the principal storm tracks and the averages of pressure, air temperature, water surface temperature, and prevailing direction of the wind at 7 a. m. 75th meridian time (Greenwich mean noon). Notes on the locations and courses of the more severe storms of the month are included in the following general summary.

PRESSURE.

The distribution of the average pressure for the month as shown on Chart IX, differed from the normal in several respects. The Atlantic HIGH was about 15 degrees north of its usual position, as the crest of 30.1 inches was near latitude 49°, longitude 21°. A LOW of 29.65 inches was in the vicinity of the Scandinavian Peninsula and a second area of low pressure of less intensity was central near latitude 42°, longitude 47°. The pressure changes from day to day were quite marked in the northern waters, and the means for the three decades of the month differed considerably in some localities, as shown in the following table. This table gives for a number of selected 5-degree squares the mean pressure for each of the three decades of the month, as well as the highest and lowest individual readings reported within the respective squares.

Pressure over the North Atlantic ocean during April, 1917, by 5-degree squares.

Position of 5-degree squares.		Decade means.			Extremes.			
					Highest.		Lowest.	
Latitude.	Longitude.	I	II	III	Pressure.	Date.	Pressure.	Date.
°	°	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*April.*	*Inches.*	*April.*
60-65 N	20-25 W	29.86	29.94	30.06	30.43	24	29.55	8
60-65 N	5-10 W	29.62	29.70	30.04	30.42	25	29.20	9
60-65 N	5-10 E	29.50	29.55	29.99	30.32	22,25	29.00	9
55-60 N	35-40 W	29.99	30.08	30.06	30.37	26	29.64	31
55-60 N	0-5 E	29.54	29.64	30.14	30.49	23	29.20	9
50-55 N	55-60 W	29.88	29.91	29.94	30.25	3	29.48	8
50-55 N	25-30 W	29.99	30.23	30.19	30.41	26	29.84	5
50-55 N	5-10 W	29.68	29.93	30.38	30.60	25	29.40	2
45-50 N	65-70 W	29.87	29.90	30.03	30.25	26	29.20	10
45-50 N	35-40 W	29.84	30.15	29.94	30.38	16	29.63	9
45-50 N	15-20 W	30.00	30.21	30.26	30.41	17	29.86	2,3
40-45 N	55-60 W	29.73	29.84	29.86	30.21	22	29.48	8
40-45 N	40-45 W	29.59	29.98	29.76	30.22	16	29.43	3,5
40-45 N	25-30 W	29.93	30.27	29.93	30.45	16	29.77	5
40-45 N	5-10 W	29.95	30.13	30.08	30.41	17	29.60	2
35, 40 N	65-70 W	29.84	29.96	30.03	30.31	18	29.49	9
35-40 N	15-20 W	30.02	30.21	30.01	30.46	17	29.90	1,2
30-35 N	75-80 W	30.04	30.06	30.01	30.39	4	29.63	14
30-35 N	50-55 W	29.80	29.98	29.94	30.21	22	29.63	8
30-35 N	30-35 W	29.89	30.11	29.87	30.37	16	29.70	27
25-30 N	60-65 W	30.04	30.04	30.00	30.32	1	29.75	7
25-30 N	20-25 W	29.98	30.09	29.95	30.33	16	29.80	28
20-25 N	45-50 W	30.00	30 02	29.95	30.18	18	29.88	24
15-20 N	75-80 W	29.99	29.94	29.95	30.03	3,5	29.84	24
15-20 N	30-35 W	29.99	30 03	29.94	30.10	18	29.85	24

The means and extreme values presented in the above table are based on the interpolated daily pressures for each square on the MS. daily synoptic charts of the North Atlantic Ocean compiled by the Marine Section of the Weather Bureau.

GALES.

The days on which gales occurred during the month was considerably less than usual, except over a small territory between the Azores and the Bermudas where the number was slightly above the normal.

From April 2 to 6, 1917, a fairly well developed area of low pressure covered the region between the 35th and 45th parallels and the 35th and 50th meridians. The movement of this LOW was slight and irregular, and it reached its maximum intensity in the 4th, when wind velocities of 75 miles an hour were recorded near latitude 35°, longitude 40°. On the 6th there was a second LOW central near New York City, and while no heavy winds were reported between that point and Cape Hatteras, moderate gales occurred along the coast south of the 33d parallel. This disturbance drifted slowly eastward, and on the 8th the center was near latitude 42°, longitude 51° and moderate gales still prevailed over a limited area between the 50th meridian and the American coast. On the evening of the 6th a LOW (*I* on Chart IX) was central near Amarillo, Tex., and by the evening of the 8th it had reached a point near Cape Hatteras. It then curved slightly toward the northeast, and on the morning of the 9th the center was near latitude 38°, longitude 69°. Southerly gales of from 40 to 50 miles an hour prevailed in the eastern quadrants, and northerly winds of about the same velocity were reported along the American coast between New York and Charleston, S. C.

On the 9th another disturbance was in the vicinity of the Scandinavian Peninsula, and northerly gales of 75 miles an hour accompanied by snow were encountered near the Faroe Islands, while off the Irish coast northwesterly winds of somewhat less force were also reported. On the 10th LOW *I* was central near Chatham, N. B., where the barometer reading was 29.08 inches, and westerly to northwesterly gales, with snow, prevailed over a limited area between the 40th and 45th parallels. The Scandinavian LOW remained practically stationary during the next 24 hours but decreasing in intensity, as on the 10th no winds of over 40 miles an hour were reported east of the 60th meridian. From the 11th to the 20th an area of low pressure remained between the 40th and 50th parallels and the 45th and 60th meridians; this moved slightly back and forth, increasing and decreasing in intensity from day to day, and on the 11th northwesterly gales of 40 miles an hour were recorded by vessels between the 68th meridian and the American coast.

From the 12th to the 20th a LOW of moderate intensity remained in the region between the American coast and the 40th meridian and the 40th and 55th parallels. During this period reports of moderate gales were received from widely scattered points west of the 35th meridian, while over the remainder of the ocean the conditions were comparatively featureless with sluggish atmospheric circulation. This area of low pressure drifted slowly eastward, increasing in extent and decreasing in intensity, until on the 21st it was central near latitude 50°, longitude 35°. It then gradually filled in and from the 22d to the 27th there were no disturbances of any consequence recorded, while light to moderate winds prevailed over the entire ocean.

From the 28th to the 30th there was a fairly well developed LOW in the region between the 38th and the 45th parallels and the 45th and 57th meridians; it moved but slightly during that period, and moderate gales were encountered in its western quadrants.

AIR TEMPERATURES.

The mean monthly temperature of the air, as compared with the normal, differed considerably over the different divisions of the North Atlantic. In the waters adjacent to the European coast and north of the 45th parallel, and west of the 30th meridian, positive departtures of from 2° to 5° were the rule, while between the 25th and 45th parallels the temperatures varied but little from the normal, being slightly above in the north and below in the south. South of the 25th parallel the departures ranged from 0° between the 15th and 25th meridians to −4° in the southern part of the Gulf of Mexico.

The seasonal rise in temperature was quite marked in northern waters, and the daily fluctuations were also comparatively large; the greatest range occurred in the square between latitude 50°-55°, longitude 50°-55°, where the thermometer read 29° F. on the 4th and 10th, and 47° F. on the 13th.

The following table gives the temperature departures for the month at a number of Canadian and United States Weather Bureau stations on the Atlantic and Gulf coasts.

	°F.		°F.
St. Johns, N. F.	+3.0	Norfolk, Va.	+1.6
Sydney, C. B. I.	+3.0	Hatteras, N. C.	+1.2
Halifax, N. S.	+2.9	Charleston, S. C.	+3.4
Eastport, Me.	−0.2	Key West, Fla.	−0.6
Portland, Me.	−2.8	Tampa, Fla.	+1.0
Boston, Mass.	−1.3	Mobile, Ala.	+0.6
Nantucket, Mass.	−2.6	New Orleans, La.	+0.3
Block Island, R. I.	−1.8	Galveston, Tex.	−0.9
New York, N. Y.	−0.9	Corpus Christi, Tex.	−0.1

WATER SURFACE TEMPERATURE.

The mean monthly surface water temperature as compared with the normal, were about as variable as those of the air, especially north of the 40th parallel, and west of the 50th meridian. In the vicinity of the "cold wall," or where the Labrador current and the Gulf Stream meet and where the daily fluctuations are usually large, the mean water temperature for the month was somewhat above the normal. In the waters adjacent to the American coast the conditions were reversed, the negative departures gradually decreasing from Halifax toward the Virginia Capes. In the waters adjacent to the European coast and in the vicinity of the Madeira Islands the temperatures were 1 to 3° higher than usual, while in mid-ocean south of the 30th parallel they were nearly normal.

FOG.

The number of days with fog is usually somewhat larger in April than in March. Off the Banks of Newfoundland, however, where the maximum amount usually occurs, fog was reported during April, 1917, on 2 days only, while the average percentage for that locality is from 35 to 40.

Off the shoals of Nantucket and along the New England coast fog was reported on 4 days, which is only slightly below the normal, while in the steamer lanes it was comparatively rare. Fog was observed on 3 days in the vicinity of the Azores, and on 1 day off the Virginia coast.

HAIL AND SNOW.

The amount of hail and snow was, as usual, less in April than in the previous month. During the month under discussion both hail and snow were observed on 3 days over the eastern part of the steamer lanes where the maximum amount occurred. They were not reported on more than 1 day in any 5° square west of the 20th meridian.

Winds of 50 mis./hr. (22.4 m./sec.) or over, during April, 1918.

Station.	Date.	Velocity.	Direction.	Station.	Date.	Velocity.	Direction.
		Mis./hr.				*Mis./hr.*	
Bismarck, N. Dak.	16	52	w.	Nantucket, Mass.	12	58	ne.
Block Island, R. I.	11	56	ne.	New York, N. Y.	22	52	nw.
Do.	12	50	ne.	Do.	23	50	nw.
Buffalo, N. Y.	18	50	sw.	North Head, Wash.	1	52	nw.
Do.	22	53	sw.	Do.	8	56	se.
Canton, Ohio	18	52	e.	Do.	13	56	se.
Corpus Christi, Tex	29	64	n.	Do.	14	60	se.
Devils Lake, N.				Pensacola, Fla.	7	65	s.
Dak.	28	50	n.	Pierre, S. Dak.	28	53	nw.
Drexel, Nebr.	28	50	w.	Point Reyes Light,			
Evansville, Ind.	1	51	sw.	Cal.	1	78	nw.
Fort Smith, Ark.	16	58	w.	Do.	2	70	nw.
Hatteras, N. C.	26	62	e.	Do.	10	62	nw.
Do.	27	54	n.	Do.	11	61	nw.
Little Rock, Ark.	16	52	w.	Do.	12	67	nw.
Jacksonville, Fla.	4	58	w.	Do.	13	62	nw.
Kansas City, Mo.	15	55	e.	Do.	14	70	nw.
Memphis, Tenn.	3	50	nw.	Do.	15	66	nw.
Do.	17	52	nw.	Do.	23	50	nw.
Do.	27	52	sw.	Do.	30	54	nw.
Mobile, Ala.	7	58	sw.	Port Arthur, Tex.	5	55	w.
Modena, Utah	2	58	s.	Providence, R. I.	24	58	w.
Mt. Tamalpais, Cal.	2	62	w.	Sandy Hook, N. J.	10	55	ne.
Do.	9	50	nw.	Do.	11	56	ne.
Do.	12	72	nw.	Do.	12	53	ne.
Do.	13	72	nw.	Sioux City, Iowa	28	52	w.
Do.	14	74	nw.	Do.	29	59	nw.
Do.	18	56	ne.	Tatoosh I., Wash.	8	50	s.
Do.	19	62	nw.	Toledo, Ohio	17	50	sw.
Do.	20	56	nw.	Do.	29	53	sw.
Do.	28	56	nw.	Wilmington, N. C.	26	60	ne.
Nantucket, Mass.	11	54	ne.				

CONDENSED CLIMATOLOGICAL SUMMARY.

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, April, 1918.

Section.	Temperature.								Precipitation.					
	Section average.	Departure from the normal.	Monthly extremes.						Section average.	Departure from the normal.	Greatest monthly.		Least monthly.	
			Station.	Highest.	Date.	Station.	Lowest.	Date.			Station.	Amount.	Station.	Amount.
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	60.8	−2.1	Tuscaloosa	92	3	Valley Head	25	10	7.60	+2.88	Citronelle	12.68	Goodwater	3.41
Arizona	58.1	−0.4	Sentinel	99	29	Greer	10	21	0.12	−0.37	Young	0.86	34 stations	0.00
Arkansas	59.6	−1.2	Dardanelle	96	2	Gravette	25	10	7.63	+2.63	Brinkley	14.34	Gravette	2.68
California	56.5	−0.5	2 stations	99	29†	Tamarack	−5	4	0.79	−1.00	Branscombe	5.17	31 stations	0.00
Colorado	39.4	−4.3	Lamar	81	25	Dillon	−19	20	1.54	−0.32	Silver Lake	7.59	Dove Creek	T.
Florida	69.1	−0.9	Clermont	96	29	Garniers (near)	28	12	5.55	+3.59	Pensacola	13.90	Boca Grande	0.39
Georgia	61.7	−1.4	Statesboro	93	4	2 stations	28	11†	5.60	+2.13	Tate	10.15	Lumber City	2.00
Hawaii (for March)	67.2	−0.8	Mahukona	87	13	Glenwood	40	2	13.64	+5.67	Eke Maui	60.50	Mahukona	1.53
Idaho	44.2	−1.5	Weiser	85	30	Bonanza	−6	3	0.87	−0.41	Whitebird	2.54	Hotspring	0.00
Illinois	47.9	−4.1	Equality	84	16	Mt. Carroll	21	5	5.39	+2.14	Sparta	10.05	Galva	2.06
Indiana	48.9	−3.2	Vincennes	84	16	Veedersburg	20	13	4.16	+0.78	Princeton	8.48	Auburn	1.98
Iowa	44.8	−3.9	2 stations	79	1	Lake Park	12	8	2.32	−0.54	Olin	4.20	Humboldt	1.01
Kansas	48.6	−5.4	3 stations	89	2	3 stations	20	6†	3.18	+0.80	Abilene	6.30	New Ulysses	0.79
Kentucky	53.9	−2.0	Greenville	87	3	Cherokee Park	25	10	4.07	+0.13	Alpha	7.75	Lexington	2.09
Louisiana	66.6	−1.2	2 stations	98	4†	2 stations	29	11	7.07	+2.58	New Orleans No. 2	11.24	Robeline	3.45
Maryland-Delaware	51.2	−1.2	Salisbury, Md	83	18	Deek Park, Md	15	5	5.69	+2.34	Cheltenham, Md	10.10	Darlington, Md	2.72
Michigan	41.1	−2.0	4 stations	76	6†	Mio	−4	19	1.97	−0.33	Wasepi	3.18	Humboldt	0.77
Minnesota	41.8	−1.5	Moose Lake	78	15	Grand Rapids	−1	23	1.79	−0.33	Park Rapids	3.15	State Sanatorium	0.00
Mississippi	62.8	−1.7	Moorhead	92	3	2 stations	28	12	7.80	+2.80	Pearlington	12.78	Pontotoc	2.70
Missouri	50.8	−4.4	Warsaw	93	2	Bethany	19	11	5.10	+1.24	Hollister	12.14	Tarkio	1.64
Montana	40.6	−1.5	Boulder	88	27	Glacier Park	−8	4	1.06	+0.08	Red Lodge	4.23	Blackleaf	0.03
Nebraska	43.6	−5.4	Auburn	80	1	Kimball	9	24	2.17	−0.24	Paxton	4.27	Albion	0.57
Nevada	46.4	−1.6	Logandale	92	30	Marlette Lake	−8	3	0.38	−0.36	Eureka	1.45	4 stations	0.00
New England	44.1	+0.9	3 stations	80	30†	Patten, Me.	5	18	2.83	−0.31	Kingston, R. I	5.60	Enosburg Falls, Vt	0.91
New Jersey	49.8	+0.8	5 stations	81	2	Culvers Lake	18	5†	4.05	+0.52	Newton	5.79	Newark	2.88
New Mexico	49.8	−1.9	Artesia	94	26	Winsors	4	19	0.45	−0.65	Des Moines	3.15	24 stations	0.00
New York	44.8	+0.5	Oneonta	84	1	North Lake (4)	11	5	3.00	+0.10	Mohonk Lake	6.21	Chazy	0.51
North Carolina	55.9	−1.5	4 stations	89	2†	Altapass	20	6	6.37	+2.83	Lumberton	13.74	Asheville	2.74
North Dakota	41.4	−0.3	Sanish	81	13	Walhalla	0	8	2.14	+0.76	Wahpeton	3.69	Bottineau	0.75
Ohio	48.7	−1.2	2 stations	83	2	3 stations	18	5	3.23	+0.03	Eaton	5.62	Danbury	1.21
Oklahoma	56.1	−4.0	Sallisaw	98	2	2 stations	25	10†	3.26	+0.03	Broken Bow	10.92	Beaver	0.92
Oregon	48.1	−1.0	Stanfield	89	8	Crescent	0	4	0.97	−1.81	Glenora	4.49	4 stations	T.
Pennsylvania	48.2	−0.4	Gettysburg	81	2	Somerset	12	5	4.53	+1.25	Bloserville	8.83	Clarion	1.84
Porto Rico	75.4	+0.1	2 stations	98	14†	Aibonito	51	1	3.62	−1.35	Inabon Falls	9.00	Hac. Isidora	0.82
South Carolina	61.0	−1.3	Oaks	92	3	3 stations	32	6†	5.82	+2.94	Oaks	15.11	Charleston	2.49
South Dakota	42.1	−3.5	Mobridge (2)	82	25	Cottonwood	7	4	2.73	T.	Lead	7.82	Camp Crook	0.83
Tennessee	57.2	−1.0	2 stations	90	3	Mountain City	21	5	5.68	+1.08	Sewanee	10.16	Johnson City	2.56
Texas	65.1	−0.8	Encinal	104	2	Lieb	20	6	3.99	+1.03	Palestine	11.24	6 stations	0.00
Utah	44.5	−2.8	Springdale	88	23	Blacks Fork	−18	4	0.77	−0.41	Manila	2.51	3 stations	0.00
Virginia	52.6	−1.6	3 stations	84	17†	Burkes Garden	19	5	6.16	+2.90	Leeds Manor	9.75	Ivanhoe	2.49
Washington	49.0	+0.4	Wahluke	90	20	2 stations	9	3	0.93	−1.21	Paradise Inn	5.62	8 stations	0.00
West Virginia	50.3	−1.2	Bancroft	85	2	Bayard	18	5	5.11	+1.54	Romney	9.14	Clay	1.88
Wisconsin	40.5	−3.5	Oshkosh	78	13	Ashland	2	18	2.14	−0.24	Reedsburg	3.79	Deerskin Dam	0.56
Wyoming	35.0	−5.8	Newcastle	86	25	Foxpark	−17	20	2.14	+0.44	Crow Hill	7.23	Elk Mountain	0.30

† Other dates also.

DESCRIPTION OF TABLES AND CHARTS.

(See the Review for January, 1918, p. 48.)

TABLE I.—*Climatological data for Weather Bureau Stations, April, 1918.*

Districts and stations.	Elevation of instruments: Barometer above sealevel.	Elevation of instruments: Thermometer above ground.	Elevation of instruments: Anemometer above ground.	Pressure: Station, reduced to mean of 24 hours.	Pressure: Sealevel, reduced to mean of 24 hours.	Pressure: Departure from normal.	Temperature of the air: Mean max.+mean min.÷2.	Temperature of the air: Departure from normal.	Temperature of the air: Maximum.	Temperature of the air: Date.	Temperature of the air: Mean maximum.	Temperature of the air: Minimum.	Temperature of the air: Date.	Temperature of the air: Mean minimum.	Temperature of the air: Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew point.	Mean relative humidity.	Precipitation: Total.	Precipitation: Departure from normal.	Precipitation: Days with 0.01 inch or more.	Wind: Total movement.	Wind: Prevailing direction.	Wind: Maximum velocity: Miles per hour.	Wind: Maximum velocity: Direction.	Wind: Maximum velocity: Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness.	Total snowfall.	Snow on ground at end of month.
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles.								0-10	In.	In.
New England.							**44.2**	**+0.6**										**72**	**2.97**	**0.0**										**5.4**		
Eastport	76	67	85	29.95	30.04	+0.11	38.7	+0.4	63	23	46	22	18	32	31	34	29	73	2.10	−0.8	9	8,123	nw.	40	s.	21	13	9	8	4.8	2.7	0.0
Greenville, Me	1,070	6		28.86	30.04		39.7		71	28	52	16	10	28	44				1.66		9						14	6	10		2.2	0.0
Portland, Me	103	82	117	29.94	30.07	+ .11	42.9	−0.1	71	23	51	26	18	34	31	37	30	65	2.70	−0.4	8	7,157	n.	34	nw.	25	12	9	9	5.2	4.2	0.0
Concord	288	70	79	29.74	30.06	+ .07	44.4	+0.6	78	30	56	23	20	33	44				2.26	−0.5	10	4,305	n.	27	w.	24	17	6	7	3.8	10.2	0.0
Burlington	404	11	48	29.63	30.08	+ .03	42.5	+1.8	73	28	52	17	10	33	38				1.67	−0.2	8	7,879	n.	38	s.	7	9	10	11	5.6	4.6	0.0
Northfield	876	12	60		30.08	+ .03	41.0	+0.8	71	28	53	17	20	29	45			67	2.28	+0.2	10	5,981	s.	32	se.	29	12	7	11	5.6	15.0	0.0
Boston	125	115	188	29.91	30.05	+ .08	47.8	+2.5	76	1	56	31	5	40	31	42	37	72	3.08	−0.5	8	7,700	e.	35	e.	11	11	9	10	5.1	4.2	0.0
Nantucket	12	14	90	30.02	30.03	+ .06	43.4	−0.8	63	15	49	32	11	38	27	40	37	85	3.84	+1.2	11	13,191	ne.	58	ne.	12	11	5	14	6.3	T.	0.0
Block Island	26	11	46	30.00	30.03	+ .05	43.4	−0.4	62	17	49	32	4	38	25	40	38	88	3.41	−0.2	9	12,787	ne.	56	ne.	11	9	5	16	6.5	0.2	0.0
Narragansett Pier		9					43.8	−0.8	64	15	51	26	5	36	2				4.99		14		ne.				14	6	10		0.5	0.0
Providence	160	215	251	29.86	30.04	+ .06	47.2	+0.6	74	2	56	30	5	38	32	40	33	65	3.74	0.0	10	9,214	nw.	58	w.	24	8	11	11	5.5	1.1	0.0
Hartford	159	122	140	29.87	30.04	+ .05	47.8	+1.1	75	2	58	30	5	38	36	41	33	63	3.36	−0.2	14	5,675	n.	29	w.	22	10	9	11	5.2	4.5	0.0
New Haven	106	117	155	29.93	30.04	+ .05	47.8	+1.4	75	2	56	31	12	39	32	42	36	69	4.26	+0.7	12	7,168	n.	32	ne.	10	10	7	13	5.9	1.6	0.0
Middle Atlantic States.							**50.6**	**−0.1**										**72**	**4.63**	**+1.6**										**6.5**		
Albany	97	102	115	29.94	30.05	+0.05	46.6	+0.8	74	28	57	24	10	36	38	40	32	63	2.48	+0.1	13	5,761	s.	33	s.	7	14	4	12	5.1	2.6	0.0
Binghamton	871	10	6	29.11	30.05	+ .0	46.0	+1.6	75	1	56	25	5	36	37				3.97	+1.7	15	3,994	nw.	24	sw.	18	7	9	14	6.5	12.7	0.0
New York	314	414	454	29.69	30.03	+ .0	49.8	+1.7	76	2	58	30	11	42	26	43	35	63	3.78	+0.5	12	11,142	ne.	52	nw.	22	5	10	15	6.9	2.6	0.0
Harrisburg	374	94	104	29.64	30.04	+ .02	50.0	−0.7	77	2	59	30	9	41	32	43	36	65	4.74	+2.2	12	4,868	w.	33	nw.	23	4	13	13	6.6	1.5	0.0
Philadelphia	117	123	190	29.88	30.01	.00	52.2	+1.4	76	2	61	32	11	44	28	49	47	87	4.42	+1.5	11	8,651	nw.	46	ne.	10	7	6	17	6.9	T.	0.0
Reading	325	81	98	29.68	30.04		51.0		78	2	60	32	5	42	32	43	35	61	5.02	+1.8	13	5,340	n.	31	nw.	23	6	8	16	6.7	0.2	0.0
Scranton	805	111	11	29.17	30.05	+ .04	48.1	+1.0	75	1	58	28	5	39	34	43	39	77	3.98	+1.3	14	5,575	sw.	30	sw.	22	7	9	14	6.6	12.1	0.0
Atlantic City	52	37	48	29.96	30.02	+ .02	47.5	−0.1	77	2	54	32	5	41	[illegible]	44	41	81	4.5	+1.5	13	6,883	ne.	35	ne.	11	5	11	14	6.4	T.	0.0
Cape May	18	13	4	30.02	30.04	+ .05	49.1	+0.7	78	2	56	34	5	43	[illegible]				2.94	0.0	11		s.				7	11	12	6.0	0.0	0.0
Sandy Hook	22	10	57	30.01	30.0		47.8		7[illegible]	2	54	33	11	41	31	43	40	79	3.46		12	11,598	ne.	56	ne.	11	5	12	13	6.3	0.9	0.0
Trenton	190	159	18	29.81	30.02		50.1		76	2	60	31	11	41	32	44	38	70	3.25	0.0	10	9,742	ne.	46	ne.	11	8	8	14	6.4	0.7	0.0
Baltimore	123	100	113	29.83	30.02	+ .01	53.0	0.0	80	17	61	33	11	45	30	46	40	66	6.7	+3.5	15	5,916	n.	39	ne.	10	4	14	12	6.4	0.0	0.0
Washington	112	62	85	29.89	30.02	.00	53.2	+0.1	81	17	63	31	6	44	34	47	41	68	6.58	+3.3	14	5,654	n.	35	ne.	10	7	10	13	6.1	3.0	0.0
Lynchburg	681	153	188	29.26	30.00	− .02	53.3	−2.[illegible]	79	2	64	29	6	43	38	47	43	73	4.97	+1.8	15	5,851	w.	42	nw.	23	5	11	14	6.8	2.4	0.0
Norfolk	91	170	205	29.90	30.00	− .01	56.4	+0.4	81	17	65	34	12	48	30	50	46	75	4.81	+1.0	12	10,623	ne.	42	nw.	24	8	9	13	6.3	0.0	0.0
Richmond	144	11	52	29.85	30.01	− .01	54.7	−2.5	80	17	65	32	11	45	37	49	44	74	8.02	+4.6	18	6,588	ne.	36	nw.	17	5	9	16	7.2	2.7	0.0
Wytheville	2,293	49	55	27.62	30.01	− .02	48.6	−3.4	74	24	57	26	10	40	36	44	41	78	3.73	+0.1	19	5,092	w.	35	w.	3	8	10	12	6.3	0.7	0.0
South Atlantic States.							**60.5**	**−0.8**										**77**	**5.35**	**+1.9**										**6.1**		
Asheville	2,255	70	84	27.64	30.00	−0.03	52.5	−1.4	79	24	62	28	10	43	34	46	42	73	2.74	−1.3	16	7,247	se.	35	e.	25	3	14	13	6.8	0.1	0.0
Charlotte	773	153	161	29.15	30.00	− .03	57.4	−1.8	8[illegible]	2	67	37	6	48	32	51	46	74	5.47	+1.4	1[illegible]	4,577	ne.	26	w.	3	4	11	15	6.9	0.0	0.0
Hatteras	11	12	50	29.96	29.97	− .04	57.0	−1.0	73	2	6	38	6	51	18	54	51	85	5.34	+0.9	10	11,473	sw.	62	e.	26	6	10	14	6.3	0.0	0.0
Manteo	12	4	46				55.5		8[illegible]	18	64	27	6	47					7.16	+2.6	9		sw.				13	8	9		0.0	0.0
Raleigh	376	103	110	29.58	29.9[illegible]	− .04	57.0	−2.0	85	3	67	32	11	47	2	52	49	79	6.96	+3.5	14	6,180	ne.	33	ne.	9	6	9	15	6.5	T.	0.0
Wilmington	78	81	91	29.91	29.9[illegible]	− .04	61.2	+0.8	8	2	70	36	12	52	26	55	51	76	6.24	+3.4	10	6,302	sw.	60	ne.	26	10	10	10	5.2	0.0	0.0
Charleston	48	11	92	29.9	29.98	− .05	63.5	−0.3	8	21	71	43	12	56	24	58	55	79	2.49	−0.5	9	8,566	sw.	47	e.	8	11	8	11	5.1	0.0	0.0
Columbia, S. C	351	41	57	29.61	29.99	− .04	61.6	−1.2	84	3	70	37	12	53	26	54	50	74	7.2	+4.4	14	5,495	ne.	33	n.	3	8	8	14	6.3	0.0	0.0
Greenville, S. C	1,039	113	122	28.88	29.97		56.6		82	4	65	36	12	48	30	51	47	74	4.84		14	7,425	ne.	38	nw.	3	5	13	12	6.4	T.	0.0
Augusta	180	62	77	29.78	29.97	− .06	62.7	−0.5	86	4	72	36	12	53	28	56	53	77	4.80	+1.3	11	4,480	se.	24	se.	7	5	9	16	7.1	0.0	0.0
Savannah	65	150	194	29.91	29.98	− .05	65.0	+0.3	88	4	73	38	12	57	28	58	54	78	4.49	+1.5	12	8,599	w.	38	e.	5	9	9	12	6.0	0.0	0.0
Jacksonville	43	200	245	29.94	29.99	− .05	67.0	−0.6	86	2	74	42	12	60	22	60	57	76	5.96	+3.2	12	9,097	sw.	58	w.	4	10	13	7	5.1	0.0	0.0
Florida Peninsula.							**73.8**	**+0.2**										**73**	**3.06**	**+1.1**										**3 4**		
Key West	22	10	64	29.94	28.96	−0.06	76.7	+1.2	86	27	82	64	14	72	16	69	66	71	2.80	+1.5	3	7,301	se.	42	sw.	19	22	6	2	2.2	0.0	0.0
Miami	25	71	79	29.96	29.99		73.6	−0.6	89	26	80	49	13	67	24	67	64	73	4.49	+1.9	9	6,620	e.	30	e.	6	15	10	5	3.8	0.0	0.0
Sand Key	23	39	72	29.92	29.95	− .07	75.6		85	27	78	66	11	73	13	70	67	75	1.93		4	10,023	se.	44	w.	7	22	4	4	2.7	0.0	0.0
Tampa	35	79	92	29.94	29.98	− .08	71.2	+0.6	87	27	80	46	11	63	28	63	60	74	1.89	0.0	5	5,320	ne.	30	sw.	25	9	15	6	5.0	0.0	0.0
East Gulf States.							**62.7**	**−2.0**										**76**	**8.32**	**+4.2**										**6.4**		
Atlanta	1,174	190	216	28.74	29.98	−0.05	57.9	−3.2	80	3	66	31	11	50	26	52	48	74	6.98	+3.4	16	8,706	nw.	38	nw.	9	6	5	19	7.0	0.2	0.0
Macon	370	78	87	29.58	29.98	− .05	62.4	−0.7	83	16	72	37	12	53	32	55	50	70	3.53	+0.1	13	4,881	nw.	26	nw.	28	5	6	19	7.4	T.	0.0
Thomasville	273	49	58	29.67	29.97	− .06	64.5	−2.2	83	3	74	35	11	55	32	58	54	76	5.02	+1.4	12	3,443	sw.	31	sw.	28	5	10	15	6.5	0.0	0.0
Pensacola	56	149	185	29.90	29.96	− .06	63.6	−4.1	75	3	69	38	12	58	22	61	58	85	13.90	+10.7	11	9,753	se.	65	s.	7	3	12	15	6.8	0.0	0.0
Anniston	741	9	57	29.18	29.98	− .05	59.0	−1.4	82	3	69	30	12	49	30				8.33	+4.7	12	4,827	se.	24	n.	9	7	13	10	6.0	T.	0.0
Birmingham	700	11	48	29.22	29.99	− .0[illegible]	60.4	−3.1	85	3	70	31	12	51	2[illegible]	53	49	72	7.17	+3.5	11	5,780	s.	36	se.	6	4	12	14	6.8	T.	0.0
Mobile	57	125	161	29.90	29.96	− .06	64.8	−1.2	83	3	72	38	11	57	26	60	57	81	11.11	+6.8	12	7,677	s.	58	sw.	7	3	17	10	6.3	0.0	0.0
Montgomery	22[illegible]	100	112	29.72	29.98	− .05	62.6	−2.6	85	3	71	35	11	54	27	56	51	72	5.96	+1.7	11	5,316	se.	23	n.	8	5	11	14	6.5	0.0	0.0
Corinth	469	6																														
Jackson	304	5																														
Meridian	375	85	93	29.57	29.96	− .06	62.2	−1.9	87	3	72	32	12	53	30	56	5[illegible]	77	10.36	+5.3	10	4,601	n.	32	n.	7	11	11	8	5.0	0.0	0.0
Vicksburg	247	65	74	29.70	29.98	− .02	64.2	−1.0	85	2	73	39	10	55	26	57	52	73	8.41	+3.2	12	5,530	se.	34	se.	16	6	15	9	5.8	0.0	0.0
New Orleans	51	76	84	29.90	29.95	− .05	67.8	−0.1	86	4	75	45	10	60	24	63	61	84	10.73	+5.8	12	5,230	s.	25	nw.	6	10	10	10	5.8	0.0	0.0
West Gulf States.							**64.4**	**−1.4**										**72**	**5.89**	**+2.4**										**5.3**		
Shreveport	249	77	93	29.67	29.94	−0.03	63.8	−2.0	88	2	74	40	21	54	31	56	51	68	5.28	+0.7	1[illegible]	6,095	se.	36	w.	5	14	8	8	4.3	0.0	0.0
Bentonville	1,303	11	44	28.55	29.92	− .04	54.2	−2.7	87	2	65	30	10	43	38				2.90	−1.0	10	4,874	n.	28	se.	15	16	7	7	4.1	0.0	0.0
Forth Smith	457	79	94	29.44	29.92	− .04	59.9	−1.8	92	2	70	36	21	49	36	52	47	70	4.12	+0.2	9	7,059	e.	58	w.	16	12	8	10	4.6	0.0	0.0
Little Rock	357	139	147	29.56	29.94	− .04	60.7	−2.0	90	3	70	39	11	52	31	52	46	65	8.42	+3.9	11	7,901	e.	52	w.	16	13	10	7	5.0	0.0	0.0
Brownsville	57	4	26				76.2		94	4	86	48	11	67	30				2.59		3		s.								0.0	0.0
Corpus Christie	20	63	77	29.87	29.89	− .06	70.8	−0.1	92	17	75	53	11	67	27	66	63	82	5.17	+3.4	5	10,958	se.	64	n.	29	7	8	15	6.7	0.0	0.0
Dallas	512	103	117	29.37	29.91		63.8		94	2	74	41	21	53	31				6.14		7	7,554	s.	40	ne.	5	7	15	8	5.6	0.0	0.0
Fort Worth	670	103	114	29.18	29.89	− .05	63.4	−1.9	94	2	75	39	21	52	32	55	50	68	6.21	+3.6	6	9,218	nw.	37	se.	14	11	12	7	5.0	0.0	0.0
Galveston	54	106	114	29.87	29.93	− .04	68.3	−0.4	83	17	73	47	10	64	17	63	59	75	6.63	+3.5	10	9,529	se.	39	se.	19	10	8	12	5.8	0.0	0.0
Houston	138	111	12[illegible]	29.77	29.92		68.5	−1.1	89	2	76	44	10	61	26				7.20		11	6,989	se.	31	n.	24	8	12	10	5.3	0.0	0.0
Palestine	510	64	72	29.39	29.92	− .04	61.0	−1.9	90	3	73	40	10	53	30	58	55	78	11.24	+7.2	10	6,111	ne.	42	nw.	24	6	9	15	6.7	0.0	0.0
Port Arthur	34	58	66	29.88	29.92		66.8		81	25	73	39	10	60	25	62	59	79	5.68		7	7,960	s.	55	w	5	10	9	11	5.1	0.0	0.0
San Antonio	701	119	132	29.16	29.88	− .05	68.9	−0.1	96	2	79	47	10	59	34	59	53	66	5.14	+2.2	6	6,932	se.	35	n.	18	16	4	10	5.0	0.0	0.0
Taylor	582	55	63	29.32	29.93	− .02	65.6	−1.9	90	3	76	40	11	55	34				3.84	−0.1	10	6,933	s.	37	nw.	5	11	6	13	5.7	0.0	0.0

TABLE I.—*Climatological data for Weather Bureau Stations, April, 1918*—Continued.

Districts and stations.	Elevation of instruments: Barometer above sea level.	Elevation of instruments: Thermometer above ground.	Elevation of instruments: Anemometer above ground.	Pressure: Station, reduced to mean of 24 hours.	Pressure: Sea level, reduced to mean of 24 hours.	Pressure: Departure from normal.	Temperature of the air: Mean max.+mean min.÷2.	Temperature of the air: Departure from normal.	Temperature of the air: Maximum.	Temperature of the air: Date.	Temperature of the air: Mean maximum.	Temperature of the air: Minimum.	Temperature of the air: Date.	Temperature of the air: Mean minimum.	Temperature of the air: Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew point.	Mean relative humidity.	Precipitation: Total.	Precipitation: Departure from normal.	Precipitation: Days with 0.01 inch or more.	Wind: Total movement.	Wind: Prevailing direction.	Wind: Maximum velocity: Miles per hour.	Wind: Maximum velocity: Direction.	Wind: Maximum velocity: Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness.	Total snowfall.	Snow on ground at end of month.
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles.								0-10	In.	In.
Ohio Valley and Tennessee.							52.6	-2.0										70	4.15	+0.6										7.0		
Chattanooga	762	189	213	29.18	29.99	-0.04	57.8	-2.2	82	2	66	33	11	50	28	52	47	72	8.05	+3.7	15	7,423	sw.	48	nw.	3	2	10	18	7.3	T.	0.0
Knoxville	996	102	111	28.92	29.97	-.06	57.0	-0.4	79	25	66	32	10	48	27	51	47	74	5.41	+0.8	14	5,622	n.	36	s.	28	4	13	13	6.8	T.	0.0
Memphis	399	76	97	29.56	29.98	-.02	60.0	-1.8	87	2	69	33	9	51	33	53	48	71	4.57	-0.3	12	7,052	n.	52	w.	17	10	7	13	6.1	T.	0.0
Nashville	546	168	191	29.40	29.99	-.02	57.0	-2.1	83	3	66	31	10	48	30	50	44	67	3.39	-1.0	12	8,491	ne.	44	nw.	1	3	16	11	6.7	T.	0.0
Lexington	989	193	230	28.91	29.99	-.03	51.8	-1.9	75	2	60	26	10	43	27	......	......	......	2.09	-1.2	13	11,422	sw.	48	sw.	17	5	13	12	6.2	0.3	0.0
Louisville	525	219	255	29.42	30.00	-.01	53.2	-3.0	78	2	62	27	10	45	26	47	41	67	2.52	-1.6	12	11,023	n.	49	sw.	17	2	10	18	7.2	1.0	0.0
Evansville	431	139	175	29.52	29.99	-.01	53.0	-3.4	80	16	61	28	10	45	28	47	42	69	5.26	+1.8	16	9,977	ne.	51	sw.	1	4	14	12	6.7	1.1	0.0
Indianapolis	822	194	230	29.10	30.00	.00	48.9	-3.5	78	2	57	27	10	40	26	43	37	68	5.36	+1.9	12	10,614	ne.	44	sw.	29	4	4	22	7.4	T.	0.0
Terre Haute	575	96	129	29.35	29.98	......	49.6	......	80	16	58	25	10	41	29	45	41	77	6.24	......	17	8,757	ne.	37	n.	2	1	16	13	7.2	0.2	0.0
Cincinnati	628	11	51	29.31	30.00	-.01	50.9	-1.4	77	2	60	25	10	42	31	45	40	71	3.38	+0.4	14	7,792	ne.	37	n.	2	5	8	17	7.0	1.5	0.0
Columbus	824	173	222	29.13	30.01	-.01	49.4	-1.6	74	2	58	26	10	41	29	43	37	66	2.80	-0.1	14	10,477	se.	44	nw.	17	5	6	19	7.1	1.5	0.0
Dayton	899	181	216	29.01	29.97	-.05	49.4	-2.3	74	2	58	27	10	40	31	44	38	72	3.40	+0.5	13	9,952	ne.	42	ne.	9	5	6	19	7.1	3.0	0.0
Pittsburgh	842	353	410	29.11	30.02	.00	49.3	-1.7	74	2	58	27	10	40	30	43	36	65	2.73	-0.2	17	9,169	nw.	38	e.	11	4	3	23	7.7	7.1	0.0
Elkins	1,940	59	67	27.95	30.02	-.01	46.7	-2.0	71	28	57	21	5	36	40	42	37	73	4.66	+1.4	23	4,503	nw.	30	e.	10	4	8	18	7.3	11.0	0.0
Parkersburg	638	77	84	29.36	30.02	-.01	51.6	-1.4	77	2	61	28	10	42	34	45	40	69	4.47	+1.6	18	4,917	se.	26	sw.	17	6	6	18	7.1	8.7	0.0
Lower Lakes Region.							44.6	-0.5										68	2.25	-0.1										6.1		
Buffalo	767	247	280	29.20	30.05	+0.04	42.4	+0.1	73	28	50	24	10	35	32	37	31	68	2.41	0.0	15	12,490	sw.	53	sw.	22	8	7	15	6.2	2.5	0.0
Canton	448	10	61	29.58	30.07	......	42.3	-0.2	75	28	52	18	10	32	37	......	......	......	1.84	-0.6	12	8,855	sw.	52	e.	18	17	6	7	3.7	4.0	0.0
Oswego	335	76	91	29.68	30.05	+.04	42.4	-0.8	73	28	50	22	9	35	28	37	32	69	2.09	-0.2	13	7,660	ne.	38	ne.	9	7	8	15	6.4	3.5	0.0
Rochester	523	97	113	29.48	30.07	+.06	44.9	+1.0	75	29	54	24	9	36	28	38	30	62	2.01	-0.4	16	6,394	ne.	31	sw.	22	8	8	14	6.2	1.3	0.0
Syracuse	597	97	113	29.42	30.07	+.06	45.6	+1.2	73	28	54	22	9	37	32	......	......	......	2.69	+0.4	12	7,895	nw.	39	nw.	24	7	15	8	5.8	5.8	0.0
Erie	714	130	166	29.25	30.03	+.01	45.2	+0.7	74	28	53	25	9	37	31	39	33	66	2.81	+0.4	15	11,111	ne.	44	se.	20	5	11	14	6.4	10.4	0.0
Cleveland	762	190	201	29.20	30.03	+.01	45.8	-0.2	70	28	53	27	10	38	31	40	35	71	2.55	+0.2	16	11,254	ne.	49	ne.	10	7	11	12	6.4	1.7	0.0
Sandusky	629	62	103	29.33	30.02	.00	45.9	-1.4	71	29	54	26	9	38	30	41	36	72	1.39	-1.2	13	11,389	ne.	46	ne.	9	4	8	18	7.0	1.2	0.0
Toledo	628	208	243	29.34	30.03	+.02	45.5	-1.8	70	2	54	24	9	37	33	40	34	69	2.43	+0.2	15	12,295	sw.	53	sw.	29	6	10	14	6.3	T.	0.0
Fort Wayne	856	113	124	29.09	30.02	......	46.1	-3.2	75	16	56	24	10	37	33	40	35	70	2.00	......	15	8,810	ne.	49	sw.	29	6	9	15	6.5	T.	0.0
Detroit	730	218	245	29.21	30.04	+.02	44.6	-0.9	68	15	53	23	9	36	32	39	32	68	2.30	0.0	13	9,995	e.	39	w.	29	6	13	11	6.0	0.6	0.0
Upper Lakes Region.							39.9	-1.1										69	2.21	-0.2										5.2		
Alpena	609	13	92	29.39	30.07	+0.05	38.0	0.0	65	15	46	13	19	30	29	33	27	66	2.00	-0.2	9	8,695	se.	38	se.	29	14	6	10	4.9	4.3	T.
Escanaba	612	54	60	29.39	30.07	+.05	36.6	-0.6	58	12	45	19	9	28	32	33	28	74	1.61	-0.5	9	6,840	n.	34	ne.	18	18	4	8	3.8	1.0	0.0
Grand Haven	632	54	92	29.34	30.03	+.02	41.4	-2.6	70	15	50	21	9	33	29	36	31	70	2.54	+0.1	11	8,842	ne.	33	s.	29	10	8	12	5.4	0.3	0.0
Grand Rapids	707	70	87	29.25	30.04	+.02	44.0	-2.2	73	16	54	22	9	34	36	38	32	66	2.22	-0.2	14	5,287	e.	23	ne.	10	8	4	18	6.6	T.	0.0
Houghton	684	62	99	29.31	30.05	+.03	37.2	+0.3	66	15	47	15	8	27	35	......	......	......	1.67	-0.4	10	7,722	e.	46	w.	22	13	8	9	4.8	5.0	0.0
Lansing	878	11	62	29.08	30.03	......	42.4	-3.2	70	15	53	22	9	32	38	38	33	72	1.97	-0.6	18	4,895	ne.	24	se.	28	7	5	18	6.5	0.2	0.0
Ludington	637	60	66	29.33	30.04	......	40.2	......	64	26	49	21	10	31	33	35	29	67	2.60	......	9	7,267	e.	31	s.	29	12	7	11	5.0	0.4	0.0
Marquette	734	77	111	29.27	30.09	+.07	37.5	0.0	65	14	45	17	8	30	26	33	26	65	1.37	-0.6	11	6,934	nw.	31	sw.	22	12	10	8	4.8	4.2	0.0
Port Huron	638	70	120	29.33	30.04	+.02	41.4	-0.8	67	15	50	22	9	32	29	37	32	72	2.31	-0.2	14	9,118	ne.	45	sw.	29	8	14	8	5.0	0.4	T.
Saginaw	641	48	82	29.34	30.04	......	42.2	......	73	15	52	21	19	32	34	37	31	69	1.69	-1.0	14	8,167	ne.	40	s.	29	6	5	19	7.1	1.3	0.0
Sault Ste. Marie	614	11	61	29.37	30.08	+.05	37.6	+1.9	68	15	48	16	3	28	38	33	28	71	2.51	+0.4	8	6,876	w.	34	nw.	2	18	3	9	4.5	0.1	0.0
Chicago	823	140	310	29.13	30.03	+.03	44.0	-1.9	76	16	50	29	9	38	24	39	33	69	3.41	+0.5	14	10,474	ne.	37	sw.	28	9	7	14	6.0	T.	0.0
Green Bay	617	109	144	29.36	30.03	+.02	40.6	-0.1	69	14	49	22	19	32	34	35	28	65	2.44	0.0	9	8,949	ne.	37	ne.	2	11	10	9	5.1	1.0	0.0
Milwaukee	681	119	133	29.28	30.03	+.04	41.2	-0.6	70	16	47	28	4	35	29	37	34	78	3.15	+0.4	13	8,267	ne.	34	sw.	29	11	7	12	5.3	T.	0.0
Duluth	1,133	11	47	28.80	30.04	+.03	36.3	-2.1	61	25	45	11	8	28	29	31	22	60	2.02	-0.1	6	9,200	ne.	45	ne.	28	18	5	7	3.6	5.6	0.0
North Dakota.							42.2	+1.5										63	2.46	+0.6										5.0		
Moorhead	940	8	57	28.98	30.02	+0.03	42.6	+1.2	72	25	56	14	23	29	42	36	28	65	2.63	+0.3	9	8,621	se.	36	nw.	29	19	6	5	3.1	3.4	0.0
Bismarck	1,674	8	57	28.20	30.01	+.04	43.0	+0.4	72	25	54	16	2	32	38	36	28	62	2.13	+0.2	10	10,077	nw.	52	w.	16	8	10	12	5.9	0.7	0.0
Devils Lake	1,482	11	44	28.38	29.98	-.01	41.2	+3.0	73	13	53	14	8	30	34	34	26	64	2.86	+0.8	8	10,254	n.	50	n.	28	13	8	9	4.8	5.1	0.0
Ellendale	1,457	10	56	28.41	29.99	......	41.1	......	72	13	53	15	8	29	42	35	27	64	2.46	......	7	13,777	s.	68	n.	28	10	12	8	5.2	4.3	0.0
Grand Forks	835	12	89	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Williston	1,872	41	48	27.96	29.97	+.01	41.9	+1.4	75	13	53	14	3	31	37	35	28	62	2.22	+1.0	6	8,130	n.	44	nw.	21	7	13	10	6.0	T.	0.0
Upper Mississippi Valley.							46.4	-4.1										67	3.17	+0.2										5.7		
Minneapolis	918	10	208	28.99	29.98	......	44.2	......	70	14	55	21	8	34	30	......	......	......	0.91	-1.5	8	9,232	se.	38	nw.	7	12	9	9	4.7	T.	0.0
St. Paul	837	201	236	29.10	30.02	+0.03	43.6	-2.1	68	14	54	22	8	33	32	......	......	......	0.94	-1.4	9	9,618	se.	42	se.	15	13	9	8	4.4	2.3	0.0
La Crosse	714	11	48	29.24	30.02	+.04	43.5	-3.8	70	15	54	24	4	33	36	......	......	......	1.70	-0.6	10	4,366	nw.	19	sw.	22	15	4	11	4.8	0.6	0.0
Madison	974	70	78	28.97	30.04	+.05	41.6	-2.9	67	15	50	24	9	33	28	36	29	66	2.63	+0.2	11	7,905	ne.	33	ne.	20	8	8	14	6.2	T.	0.0
Wausau	1,247	4	......	28.67	30.03	......	39.9	......	68	14	51	19	9	28	39	......	......	......	1.58	......	9	......	e.	......	......	......	19	3	8	3.7	0.5	0.0
Charles City	1,015	10	49	28.93	30.02	+.04	43.1	-3.2	68	1	54	22	11	32	38	37	29	63	1.99	-0.8	9	5,590	se.	24	w.	28	9	13	8	5.2	3.9	0.0
Davenport	606	71	79	29.35	30.01	+.03	45.6	-4.6	72	1	54	27	9	37	28	39	33	66	2.32	-0.6	10	6,949	e.	31	sw.	29	8	7	15	6.1	0.1	0.0
Des Moines	861	84	97	29.08	30.00	+.03	46.8	-3.8	75	1	56	27	8	37	41	39	30	58	1.81	-1.2	10	6,187	se.	28	w.	28	8	7	15	6.3	3.8	0.0
Dubuque	698	81	96	29.28	30.04	+.06	44.2	-4.7	69	1	53	27	9	35	35	38	30	62	2.16	-0.8	11	5,452	ne.	24	ne.	2	9	10	11	5.6	3.4	0.0
Keokuk	614	64	78	29.32	30.00	+.02	47.0	-5.0	75	1	55	29	5	39	28	41	36	69	2.66	-0.7	11	6,723	ne.	34	sw.	29	9	12	9	5.3	T.	0.0
Cairo	356	87	93	29.57	29.95	-.04	54.8	-3.5	80	2	63	30	9	46	26	49	44	71	6.18	+2.6	11	8,660	n.	37	se.	6	4	10	16	7.3	T.	0.0
Peoria	609	11	45	29.34	30.01	+.02	45.8	-5.1	74	16	55	28	9	37	34	41	37	75	3.70	+0.4	11	6,789	ne.	30	sw.	29	7	11	12	6.3	T.	0.0
Springfield, Ill	644	10	91	29.30	29.98	.00	47.8	-4.2	78	16	56	27	10	39	36	42	37	71	5.19	+1.9	14	7,271	ne.	26	sw.	29	3	13	14	6.9	0.0	0.0
Hannibal	534	74	109	29.40	29.98	.00	48.4	-5.2	77	1	57	28	10	40	33	......	......	......	4.40	+1.2	14	7,742	ne.	36	sw.	29	6	9	15	6.5	T.	0.0
St. Louis	567	265	303	29.36	29.97	-.01	51.2	-4.9	81	16	58	30	10	44	30	45	39	68	7.09	+3.6	15	10,144	ne.	45	w.	2	7	12	11	6.6	T.	0.0
Missouri Valley.							47.0	-3.4										62	2.90	0.0										5.5		
Columbia, Mo	781	11	84	29.12	29.96	-0.02	49.4	-4.9	83	2	58	28	10	41	38	......	......	......	5.07	+1.4	13	7,202	ne.	37	ne.	2	7	12	11	6.2	T.	0.0
Kansas City	963	161	181	28.93	29.98	+.02	49.3	-5.0	78	1	58	31	24	41	30	41	32	59	2.87	-0.4	11	9,807	ne.	55	e.	15	13	8	9	4.9	2.0	0.0
St. Joseph	967	11	49	28.94	30.00	......	49.0	......	79	1	59	30	11	39	38	40	31	58	2.57	......	9	7,544	e.	38	nw.	28	11	8	11	5.4	1.5	0.0
Springfield, Mo	1,324	98	104	28.54	29.94	-.03	51.8	-3.9	86	2	61	30	10	43	26	45	40	69	4.25	+0.4	14	8,559	ne.	42	se.	15	19	5	6	3.4	0.2	0.0
Iola	984	11	50	28.89	29.95	......	51.7	-2.5	87	2	62	28	11	41	35	......	......	......	4.60	+1.8	12	6,344	ne.	31	se.	5	12	7	11	5.1	T.	0.0
Topeka	983	85	101	......	......	......	49.4	-4.3	80	1	59	29	10	39	37	......	......	......	3.64	+0.9	11	7,941	ne.	39	se.	15	12	8	10	4.9	0.4	0.0
Drexel	1,299	10	53	28.60	30.01	......	45.5	......	69	1	56	23	8	35	32	38	31	63	1.77	......	11	9,452	se.	50	w.	28	9	7	14	6.0	1.6	0.0
Lincoln	1,189	11	84	28.71	30.00	+.06	46.9	-3.8	72	1	58	25	11	36	37	39	31	60	1.89	-0.9	8	8,423	se.	48	nw.	29	9	8	13	5.8	1.2	0.0
Omaha	1,105	115	122	28.82	30.01	+.06	47.4	-3.1	71	1	57	29	8	38	29	40	31	57	1.57	-1.4	9	7,015	se.	39	ne.	2	12	5	13	5.4	0.6	0.0
Valentine	2,598	47	54	27.26	30.01	+.07	41.4	-4.0	78	25	52	18	2	31	43	36	30	70	2.40	+0.1	11	9,629	nw.	42	nw.	6	7	8	15	6.5	5.2	0.0
Sioux City	1,135	94	164	28.78	30.02	+.07	45.5	-3.0	67	13	55	23	4	36	32	38	31	60	1.55	-1.2	7	10,556	se.	59	nw.	29	11	8	11	5.4	T.	0.0
Huron	1,306	59	74	28.60	30.02	+.06	42.0	-2.6	70	13	53	18	8	31	40	35	27	61	1.94	-0.7	9	10,724	se.	48	w.	16	8	10	12	5.8	5.3	0.0
Pierre	1,572	70	75	28.30	29.99	+.04	45.2	-1.3	80	25	56	20	8	34	42	38	32	68	2.60	+0.6	13	10,024	nw.	53	nw.	28	6	11	13	6.4	4.0	0.0
Yankton	1,233	49	57	28.67	30.00	+.05	44.4	-3.0	68	13	54	22	8	34	32	......	......	......	2.40	-0.4	8	7,570	nw.	35	nw.	29	8	12	10	6.2	1.0	0.0

TABLE I.—*Climatological data for Weather Bureau Stations, April, 1918*—Continued.

Districts and stations.	Elevation of instruments. Barometer above sealevel.	Thermometer above ground.	Anemometer above ground.	Pressure. Station, reduced to mean of 24 hours.	Sealevel, reduced to mean of 24 hours.	Departure from normal.	Temperature of the air. Mean max.+mean min.÷2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew point.	Mean relative humidity.	Precipitation. Total.	Departure from normal.	Days with 0.01 inch or more.	Wind. Total movement.	Prevailing direction.	Maximum velocity. Miles per hour.	Direction.	Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness.	Total snowfall.	Snow on ground at end of month.
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles.								0-10	In.	In.
Northern Slope.							39.7	−3.1										66	1.86	+0.3										6.4		
Billings	3,140	5	....				42.8	....	80	9	54	17	27	32	45	....	....	....	1.58	....	13	....	sw.	....	....	....	7	14	9	....	....	
Havre	2,505	11	44	27.35	30.02	+0.09	42.8	+0.1	77	9	56	15	3	30	43	36	30	67	0.35	−0.7	4	5,750	sw.	36	n.	17	9	16	5	5.3	0.5	0.0
Helena	4,110	87	114	25.78	30.03	+ .06	40.4	−1.6	69	30	51	12	2	30	38	32	23	56	0.57	−0.6	8	6,558	sw.	39	n.	21	4	12	14	6.8	6.1	0.0
Kalispell	2,962	11	34	26.92	30.00	+ .04	42.6	+0.1	70	20	54	17	3	31	36	35	26	55	0.63	−0.4	6	4,746	nw.	30	sw.	24	13	11	6	4.6	T.	0.0
Miles City	2,371	48	55	27.46	30.04	+ .08	44.0	−0.7	78	9	54	23	2	34	38	37	31	69	1.67	+0.5	8	6,276	nw.	45	nw.	17	6	12	12	6.4	0.8	0.0
Rapid City	3,259	50	58	26.56	30.03	+ .08	40.2	−3.3	69	13	49	18	2	31	43	34	27	64	2.87	+0.6	11	9,160	nw.	48	nw.	17	5	8	17	6.9	13.7	0.0
Cheyenne	6,088	84	101	23.91	29.98	+ .07	34.8	−6.8	61	10	44	9	24	26	43	30	25	73	3.92	+2.1	19	9,962	n.	47	nw.	28	3	7	20	7.6	20.7	0.0
Lander	5,372	60	68	24.58	30.01	+ .07	36.6	−5.6	66	30	48	− 3	5	25	42	30	24	67	2.62	+0.2	11	3,622	sw.	34	nw.	16	6	12	12	6.1	22.0	0.0
Sheridan	3,790	10	47	26.09	30.05	......	37.2	......	70	30	47	5	5	27	42	33	28	74	3.74	......	18	5,345	nw.	38	nw.	17	3	9	18	7.2	21.8	0.0
Yellowstone Park	6,200	11	48	23.80	30.02	+ .06	32.9	−4.1	62	9	43	8	2	23	41	28	22	69	1.59	+0.2	18	6,034	nw.	29	nw.	25	3	19	8	6.3	13.6	0.0
North Platte	2,821	11	51	27.06	30.02	+ .10	42.7	−6.3	70	12	53	25	3	32	41	36	30	67	2.51	+0.4	12	7,593	se.	32	nw.	17	5	11	14	6.6	5.4	0.0
Middle Slope.							48.4	−5.3										64	3.50	+0.3										5.6		
Denver	5,292	106	113	24.64	29.94	+0.04	42.6	−5.1	68	9	52	22	3	33	33	36	30	68	2.71	+0.5	14	6,268	nw.	38	nw.	18	6	12	12	6.1	19.5	0.0
Pueblo	4,685	80	86	25.20	29.90	+ .02	45.8	−4.7	76	23	58	26	4	34	41	37	30	62	1.31	−0.1	10	5,279	e.	44	e.	26	4	16	10	6.1	2.4	0.0
Concordia	1,392	50	58	28.52	30.01	+ .08	47.6	−6.0	74	1	58	27	9	37	34	40	30	60	3.51	+1.1	9	7,116	se.	35	nw.	29	5	15	10	6.3	1.2	0.0
Dodge City	2,509	11	51	27.34	29.96	+ .06	47.8	−6.6	74	1	58	28	6	37	39	41	36	70	1.38	−0.5	9	9,285	se.	36	se.	14	13	9	8	4.7	0.0	0.0
Wichita	1,358	139	158	28.50	29.94	+ .01	50.8	−5.8	76	2	61	31	20	41	33	44	37	65	4.14	+1.4	10	10,099	ne.	48	e.	14	14	6	10	5.1	0.1	0.0
Altus	1,410	5	....	......	......	......	58.2	......	89	2	71	34	21	46	42	....	....	....	2.48	......	3	......	n.	....	......	....	17	3	10	....	0.0	0.0
Muskogee	652	4	....	......	......	......	56.4	......	89	2	69	32	11	44	45	....	....	....	3.05	......	12	......	n.	....	......	....	15	2	13	....	0.0	0.0
Oklahoma	1,214	10	47	28.65	29.93	+ .01	56.0	−3.6	88	2	67	33	10	44	42	46	38	60	2.45	−0.4	6	10,075	n.	43	nw.	27	9	12	9	5.2	0.0	0.0
Southern Slope.							61.5	−0.9										45	0.55	−1.0										3.8		
Abilene	1,738	10	52	28.09	29.88	−0.02	64.3	−0.1	96	26	78	35	21	51	43	50	36	46	1.06	−1.2	4	9,033	s.	39	ne.	18	14	9	7	4.7	0.0	0.0
Amarillo	3,676	10	49	26.18	29.90	+ .03	53.2	−1.4	87	26	68	31	21	39	41	41	30	53	0.48	−1.2	4	8,176	sw.	37	n.	16	16	11	3	3.8	0.3	0.0
Del Rio	944	64	71	28.88	29.85	− .04	71.6	+1.6	96	27	82	50	10	61	40	....	....	....	0.58	−1.4	6	7,427	se.	49	n.	18	14	13	3	3.6	0.0	0.0
Roswell	3,566	75	85	26.26	29.83	− .02	57.0	−3.6	87	26	72	29	20	42	43	43	27	37	0.07	−0.4	3	7,353	s.	33	w.	14	15	14	1	3.2	0.0	0.0
Southern Plateau.							60.5	−0.5										34	0.13	−0.2										2.4		
El Paso	3,762	110	133	26.08	29.80	−0.03	62.0	−1.8	84	25	74	37	20	50	36	44	21	24	0.00	−0.2	0	11,053	w.	41	e.	30	21	8	1	2.3	0.0	0.0
Santa Fe	7,013	57	66	23.13	29.82	− .02	45.0	−2.6	67	28	56	20	19	34	34	34	23	50	0.72	−0.1	6	6,625	sw.	36	s.	11	9	18	3	5.2	7.3	0.0
Flagstaff	6,908	8	57	......	......	......	......	......	....	....	....	....	....	....	....	....	....	....	......	......	....	......	......	....	......	....	....	....	....	....	......	......
Phoenix	1,108	76	81	28.67	29.81	− .03	67.5	+0.9	92	10	83	43	6	52	41	50	31	32	0.02	−0.4	1	4,201	e.	33	w.	13	24	5	1	1.9	0.0	0.0
Yuma	141	9	54	29.67	29.82	− .07	71.0	+0.9	97	9	87	45	14	55	41	53	35	35	0.00	−0.1	0	4,471	w.	34	n.	18	28	2	0	0.5	0.0	0.0
Independence	3,910	11	42	25.90	29.86	− .04	57.0	+0.3	81	23	72	27	3	43	38	42	22	28	0.00	−0.1	0	......	nw.	....	......	....	22	6	2	2.2	0.0	0.0
Needles	488	4	....	29.31	29.81	......	69.3	......	98	30	86	42	6	52	47	....	....	....	0.06	......	1	......	......	....	......	....	19	5	6	....	0.0	0.0
Middle Plateau.							46.8	−2.1										46	0.34	−0.8										3.9		
Reno	4,532	74	81	25.44	29.97	0.00	47.7	+0.4	77	21	62	19	4	33	41	36	22	43	0.16	−0.4	3	5,405	w.	38	w.	1	22	6	2	2.5	1.7	0.0
Tonopah	6,090	12	20	23.99	29.88	......	46.2	......	69	22	57	16	3	35	29	38	30	53	T.	−1.7	0	7,977	nw.	41	nw.	13	20	10	0	2.2	T.	0.0
Winnemucca	4,344	18	56	25.58	29.98	+ .02	45.5	−1.6	78	30	62	16	4	29	47	34	20	45	0.52	−0.4	3	4,934	ne.	30	nw.	1	13	12	5	4.0	0.3	0.0
Modena	5,479	10	43	24.52	29.86	− .02	44.6	−2.3	72	22	60	18	5	29	48	34	18	39	0.35	−0.4	2	8,322	w.	58	s.	2	13	8	9	4.5	4.5	0.0
Salt Lake City	4,360	163	203	25.55	29.92	.00	47.6	−2.5	74	9	57	24	4	39	29	38	27	48	0.59	−1.7	5	6,107	nw.	40	n.	17	9	12	9	5.0	1.0	0.0
Grand Junction	4,602	82	96	25.28	29.85	− .03	48.8	−4.4	74	23	60	27	20	37	37	38	24	45	0.43	−0.3	9	5,046	se.	41	s.	2	12	6	12	5.1	0.7	0.0
Northern Plateau.							48.4	−0.6										49	0.50	−0.8										4.5		
Baker	3,471	48	53	26.42	30.03	+0.03	43.4	−0.1	71	29	56	21	4	31	41	36	26	55	0.38	−0.6	4	5,656	se.	29	nw.	2	12	9	9	4.3	T.	0.0
Boise	2,739	78	86	27.13	30.00	+ .02	48.8	−1.3	78	30	62	22	3	36	36	39	27	48	0.65	−0.5	3	4,472	nw.	30	nw.	17	11	13	6	4.6	T.	0.0
Lewiston	757	40	48	29.23	30.04	+ .05	51.8	−1.1	79	29	66	25	3	38	40	....	....	....	0.57	−0.6	6	3,006	ne.	27	w.	24	13	6	11	4.6	0.0	0.0
Pocatello	4,477	60	68	25.40	29.93	− .01	43.4	−3.4	72	30	54	19	3	32	34	35	24	52	0.89	−1.1	7	7,253	se.	38	sw.	1	8	14	8	5.5	1.3	0.0
Spokane	1,929	101	110	27.95	30.01	+ .02	49.8	+2.1	76	20	62	22	3	38	37	39	25	44	0.18	−1.1	6	4,314	sw.	29	nw.	24	12	12	6	4.4	T.	0.0
Walla Walla	991	57	65	28.95	30.03	+ .02	53.2	+0.4	79	20	65	26	3	42	35	42	29	44	0.32	−1.4	4	4,685	s.	32	sw.	24	18	7	5	3.5	1.7	0.0
North Pacific Coast Region.							49.9	+0.8										72	1.20	−2.1										4.8		
North Head	211	11	56	29.88	30.11	+0.06	47.9	+0.4	78	19	52	38	24	43	23	46	44	89	1.40	−1.8	10	10,044	nw.	60	se.	14	13	6	11	4.9	T.	0.0
North Yakima	1,071	4	....	......	......	......	53.8	......	84	20	70	22	4	38	48	....	....	....	T.	......	0	......	nw.	....	......	....	23	3	4	....	0.0	0.0
Port Angeles	29	8	53	30.08	30.11	......	46.3	......	68	21	56	28	3	37	30	....	....	....	0.41	−1.6	4	4,884	s.	32	se.	8	16	8	6	3.7	0.0	0.0
Seattle	125	215	250	29.98	30.11	+ .08	50.0	+0.6	73	20	59	34	3	41	27	44	37	67	0.96	−1.7	8	5,704	n.	40	s.	8	12	5	13	5.2	T.	0.0
Tacoma	213	113	120	29.87	30.10	+ .08	49.5	+0.6	72	20	59	30	3	40	30	44	38	68	1.13	−1.6	10	4,389	n.	29	sw.	8	8	12	10	5.4	0.2	0.0
Tatoosh Island	86	7	57	29.99	30.09	+ .09	47.0	+0.9	65	20	51	37	14	43	15	44	41	82	2.25	−4.1	11	9,453	s.	50	s.	8	12	4	14	5.4	0.0	0.0
Medford	1,425	4	....	......	......	......	51.7	......	84	20	67	24	4	36	48	....	....	....	0.39	......	3	......	nw.	....	......	....	15	11	4	....	0.0	0.0
Portland, Oreg.	153	68	106	29.93	30.09	+ .03	52.8	+1.6	82	20	63	32	3	42	34	46	37	62	1.13	−1.9	8	3,760	nw.	21	w.	14	10	8	12	5.3	0.0	0.0
Roseburg	510	9	57	29.54	30.10	+ .03	52.0	+1.1	85	19	66	25	3	38	45	44	35	61	0.71	−1.8	6	2,282	nw.	20	s.	7	15	14	1	3.4	0.0	0.0
Middle Pacific Coast Region.							55.3	+1.7										62	0.83	−1.2										2.7		
Eureka	62	73	89	30.03	30.10	−0.01	50.7	+1.2	79	19	57	34	3	44	29	46	42	74	1.07	−2.9	5	6,374	n.	37	s.	8	13	9	8	4.8	0.0	0.0
Mount Tamalpais	2,375	11	18	27.52	29.99	− .06	52.1	+2.6	76	20	59	32	13	45	22	44	34	55	1.11	−0.3	5	13,689	nw.	74	nw.	14	22	4	4	2.6	0.0	0.0
Point Reyes Light	490	7	18	29.46	29.98	......	51.6	+3.0	81	18	56	41	3	47	31	....	....	....	0.91	......	5	18,617	nw.	78	nw.	1	17	6	7	3.8	0.0	0.0
Red Bluff	332	50	56	29.62	29.98	− .05	60.3	+1.2	91	30	72	34	4	48	40	49	35	46	0.68	−1.2	3	4,500	nw.	29	n.	2	24	2	4	2.1	0.0	0.0
Sacramento	69	106	117	29.91	29.98	− .03	59.2	+1.2	86	30	72	37	3	47	39	52	46	66	1.06	−0.9	3	6,235	s.	33	nw.	16	26	3	1	1.5	0.0	0.0
San Francisco	155	209	213	29.85	30.02	− .03	57.2	+3.5	81	19	64	45	13	50	23	50	44	68	0.60	−1.2	3	6,633	w.	31	sw.	1	21	5	4	2.7	0.0	0.0
San Jose	141	12	110	29.87	30.02	......	56.2	−0.5	86	20	70	33	4	43	41	....	....	....	0.45	−1.0	2	4,524	nw.	25	nw.	13	27	3	0	1.6	0.0	0.0
South Pacific Coast Region.							60.5	+2.4										63	0.05	−1.0										3.5		
Fresno	327	89	98	29.61	29.97	−0.02	61.8	+0.6	89	22	75	37	4	49	33	50	39	50	T.	−0.7	0	6,252	nw.	38	nw.	13	23	5	2	2.0	0.0	0.0
Los Angeles	338	159	191	29.59	29.93	− .03	61.7	+4.1	86	8	70	46	4	53	32	53	47	67	0.15	−1.0	2	4,103	sw.	29	nw.	13	14	7	9	4.4	0.0	0.0
San Diego	87	62	70	29.86	29.95	− .04	60.4	+2.2	84	20	67	47	14	54	30	53	48	70	T.	−0.7	0	4,589	w.	27	w.	13	11	12	7	4.6	0.0	0.0
San Luis Obispo	201	32	40	29.79	30.01	− .04	58.0	+2.8	88	20	69	40	3	49	39	49	43	65	0.04	−1.4	2	3,565	nw.	20	sw.	9	20	6	4	3.0	0.0	0.0
West Indies.																																
San Juan, P. R.	82	8	54	29.89	29.97	−0.01	76.0	......	89	14	82	68	10	70	19	......	......	......	1.71	−2.1	12	9,413	ne.	33	ne.	10	20	8	2	3.2	0.0	0.0
Panama Canal.																																
Balboa Heights	118	7	97	29.71	29.84	......	80.4	......	91	17	88	70	5	73	19	74	72	84	4.52	+1.6	11	6,077	n.	32	ne.	15	4	20	6	5.2	0.0	0.0
Colon	36	30	97	29.80	29.84	......	79.8	......	90	25	84	73	23	76	16	75	74	81	5.34	+1.1	17	8,393	n.	29	n.	11	3	19	8	6.5	0.0	0.0
Alaska.																																
Juneau	80	11	49	......	......	......	37.8	......	50	28	43	19	1	33	17	35	32	81	5.91	......	20	2,832	se.	17	se.	3	0	3	27	9.3	7.2	T.

Table II.—*Accumulated amounts of precipitation for each 5 minutes, for the principal storms in which the rate of fall equaled or exceeded 0.25 inch in any 5 minutes, or 0.80 in 1 hour, during April, 1918, at all stations furnished with self-registering gages.*

Stations.	Date.	Total duration.		Total amount of precipitation.	Excessive rate.		Amount before excessive rate began.	Depths of precipitation (in inches) during periods of time indicated.													
		From—	To—		Began—	Ended—		5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Abilene, Tex.	5	3:10 p. m.	5:30 p. m.	0.88	4:16 p. m.	4:56 p. m.	0.18	0.11	0.25	0.26	0.27	0.33	0.39	0.55	0.62						
Albany, N. Y.	22			0.29														0.17			
Alpena, Mich.	21			0.55														0.18			
Amarillo, Tex.	8			0.31														0.12			
Anniston, Ala.	20	12:34 p. m.	2:28 p. m.	0.82	1:12 p. m.	1:26 p. m.	0.01	0.16	0.42	0.64											
Do.	29	3:28 a. m.	9:00 a. m.	1.32	3:30 a. m.	4:13 a. m.	0.02	0.09	0.37	0.45	0.47	0.49	0.58	0.71	0.79	0.83					
Asheville, N. C.	8			0.62														0.16			
Atlanta, Ga.	8			1.30														0.55			
Atlantic City, N. J.	10			1.08														0.30			
Augusta, Ga.	19	7:05 p. m.	8:10 p. m.	0.61	7:34 p. m.	7:57 p. m.	0.08	0.09	0.30	0.36	0.47	0.53									
Baker, Oreg.	12			0.14														*			
Baltimore, Md.	21			1.44														0.40			
Bentonville, Ark.	16			0.54														0.48			
Binghamton, N. Y.	29			0.74														0.42			
Birmingham, Ala.	28	D. N. a. m.	9:35 a. m.	1.16	5:15 a. m.	5:40 a. m.	0.02	0.14	0.27	0.34	0.41	0.50									
Bismarck, N. Dak.	16			0.89														0.14			
Block Island, R. I.	21			1.33														0.54			
Boise, Idaho.	9			0.44														0.16			
Boston, Mass.	21			1.50														0.42			
Buffalo, N. Y.	17			0.71														0.30			
Burlington, Vt.	21			0.56														*			
Cairo, Ill.	1-2	8:10 p. m.	4:30 a. m.	1.58	8:21 p. m.	8:47 p. m.	0.04	0.12	0.32	0.38	0.42	0.51	0.53								
					9:10 p. m.	9:20 p. m.	0.61	0.34	0.50												
Do.	27-28	11:50 p. m.	5:20 a. m.	1.84	12:19 a. m.	1:36 a. m.	0.04	0.14	0.23	0.25	0.32	0.42	0.49	0.63	0.75	0.88	0.94	1.19	1.42		
Canton, N. Y.	21			0.72														0.16			
Charles City, Iowa.	15			0.37														0.11			
Charleston, S. C.	8			1.20														0.44			
Charlotte, N. C.	21																	0.36			
Chattanooga, Tenn.	16			1.46														0.64			
Cheyenne, Wyo.	14-15			0.98														*			
Chicago, Ill.	28			0.72														0.24			
Cincinnati, Ohio.	2-3	8:55 p. m.	2:45 a. m.	1.16	9:46 p. m.	9:57 p. m.	0.27	0.28	0.57	0.60											
Cleveland, Ohio.	16			0.68														0.37			
Columbia, Mo.	27			0.74														0.23			
Columbia, S. C.	7-8	6:00 p. m.	12:15 p. m.	3.94	7:21 a. m.	8:27 a. m.	2.49	0.09	0.16	0.24	0.29	0.36	0.45	0.52	0.56	0.59	0.66	0.83	0.95		
Columbus, Ohio.	2-3			0.65														0.34			
Concord, N. H.	12-13			0.87														*			
Concordia, Kans.	14			1.10														0.25			
Corpus Christi, Tex.	6	5:44 a. m.	9:40 a. m.	2.65	5:58 a. m.	7:35 a. m.	0.03	0.12	0.14	0.33	0.54	0.73	0.80	0.90	1.06	1.29	1.51	2.03	2.28	2.59	
	29	12:43 p. m.	2:50 p. m.	0.87	1:33 p. m.	2:03 p. m.	0.02	0.11	0.14	0.16	0.35	0.63	0.81								
Dallas, Tex.	5	12:36 a. m.	4:50 a. m.	1.97	2:09 a. m.	3:11 a. m.	0.04	0.16	0.17	0.22	0.30	0.46	0.69	0.82	0.96	1.13	1.57	1.70	1.75		
Do.	5	2:58 p. m.	9:50 p. m.	1.53	5:45 p. m.	6:07 p. m.	0.05	0.10	0.45	0.62	0.73	0.76									
Do.	13	11:31 a. m.	5:22 p. m.	0.99	11:41 a. m.	12:09 p. m.	0.01	0.06	0.24	0.40	0.50	0.56	0.62								
Do.	27	6:09 p. m.	7:29 p. m.	0.87	6:11 p. m.	6:33 p. m.	0.01	0.18	0.45	0.64	0.71	0.74									
Davenport, Iowa.	6			1.01														0.20			
Dayton, Ohio.	1			0.50														0.40			
Del Rio, Tex.	23			0.21														0.14			
Denver, Colo.	14-15			0.82														*			
Des Moines, Iowa.	20-21			0.68														*			
Detroit, Mich.	16			0.66														0.58			
Devils Lake, N. Dak.	28			1.22														0.15			
Dodge City, Kans.	13			0.18														0.13			
Drexel, Nebr.	5			0.11														0.26			
Dubuque, Iowa.	16			0.14														0.13			
Duluth, Minn.	28-29			0.92														*			
Eastport, Me.	22			0.62														0.41			
Elkins, W. Va.	3			0.61					†									0.28			
Ellendale, N. Dak.	28			0.95														*			
El Paso, Tex.	‡			‡																	
Erie, Pa.	21			0.27														0.16			
Escanaba, Mich.	28			0.74														0.16			
Eureka, Cal.	12			0.23														0.17			
Evansville, Ind.	2-3	10.45 p. m.	1:00 a. m.	1.57	11:15 p. m.	12:32 a. m.	0.12	0.20	0.34	0.36	0.36	0.37	0.37	0.39	0.51	0.82	0.97	1.02	1.33		
Flagstaff, Ariz.																					
Fort Smith, Ark.	19			0.66														0.51			
Fort Wayne, Ind.	28			0.42														0.25			
Fort Worth, Tex.	5	12:58 a. m.	4:38 a. m.	1.13	2:14 a. m.	2:34 a. m.	0.12	0.08	0.35	0.52	0.68										
Do.	13	2:21 a. m.	3:51 p. m.	2.18	10:27 a. m.	11:35 a. m.	0.56	0.24	0.38	0.52	0.69	0.78	0.84	0.90	0.94	1.02	1.07	1.22	1.39		
Do.	27	5:15 p. m.	6:10 p. m.	0.56	5:30 p. m.	5:54 p. m.	0.02	0.27	0.35	0.40	0.46	0.52									
Do.	14-15	5:45 p. m.	D. N. a. m.	0.98	6:08 p. m.	6:20 p. m.	0.07	0.24	0.55	0.60											
Fresno, Cal.	13			T.														T.			
Galveston, Tex.	5-6	10:25 p. m.	D. N. a. m.	0.87	10:32 p. m.	10.53 p. m.	0.02	0.12	0.33	0.45	0.55	0.59									
	17	4:14 a. m.	6:46 a. m.	0.70	4:26 a. m.	4:42 a. m.	0.02	0.25	0.43	0.55	0.59										
	24	4:38 p. m.	6:35 p. m.	2.21	5:46 p. m.	6:19 p. m.	0.03	0.13	0.34	0.88	1.42	1.70	1.98	2.13							
Grand Haven, Mich.	28			0.37														0.21			
Grand Junction, Colo.	13			0.12														0.11			
Grand Rapids, Mich.	28			0.38														0.17			
Green Bay, Wis.	17-18			0.59														*			
Greenville, S. C.	3	2:10 p. m.	3:30 p. m.	0.78	2:26 p. m.	2:53 p. m.	0.01	0.11	0.23	0.46	0.57	0.65	0.69								
Hannibal, Mo.	27			0.74														0.27			
Harrisburg, Pa.	29			0.37														0.37			
Hartford, Conn.	21			1.42														0.39			
Hatteras, N. C.	19	10:10 a. m.	12:10 p. m.	0.70	10:41 a. m.	11:07 a. m.	0.05	0.11	0.18	0.32	0.41	0.60	0.63								
Havre, Mont.	25			0.32														*			
Helena, Mont.	1			0.23														*			
Houghton, Mich.	28			0.62														*			
Houston, Tex.	5-6	8:55 p. m.	D. N. a. m.	1.36	9:06 p. m.	9:47 p. m.	0.01	0.20	0.41	0.56	0.66	0.82	0.92	0.99	1.05	1.09					
Do.	24	12:10 p. m.	2:58 p. m.	1.58	1:12 p. m.	2:28 p. m.	0.10	0.06	0.14	0.24	0.35	0.47	0.59	0.70	0.86	0.97	1.05	1.15	1.45		
Do.	29	6:22 a. m.	7:46 p. m.	2.67	9:14 a. m.	9:44 a. m.	0.70	0.11	0.17	0.20	0.30	0.47	0.57								
Huron, S. Dak.	15-16			0.61														*			
Independence, Cal.	‡			‡																	
Indianapolis, Ind.	1	12:52 p. m.	1:25 p. m.	0.52	1:09 p. m.	1:19 p. m.	0.01	0.18	0.51												
Iola, Kans.	16			0.72														0.67			
Jacksonville, Fla.	19	10:55 a. m.	2:20 p. m.	1.44	11:37 a. m.	12:19 p. m.	0.02	0.18	0.47	0.62	0.78	0.86	0.93	1.06	1.16	1.21					
Kalispell, Mont.	17			0.34														*			
Kansas City, Mo.	24-25			0.66														*			
Keokuk, Iowa.	6			1.08														0.32			
Key West, Fla.	7-8	D. N. p. m.	D. N. a. m.	1.36	10:49 p. m.	11:34 p. m.	0.07	0.07	0.34	0.54	0.69	0.71	0.78	0.87	0.93	0.98					
Knoxville, Tenn.	20	3:10 p. m.	D. N. p. m.	1.17	5:14 p. m.	5:27 p. m.	0.09	0.22	0.54	0.63											
La Crosse, Wis.	6			0.53														0.10			

* Self-register not in use. † Record partly estimated. ‡ No precipitation occurred during month.

TABLE II.—*Accumulated amounts of precipitation for each 5 minutes, for the principal storms in which the rate of fall equaled or exceeded 0.25 inch in any 5 minutes, or 0.80 in 1 hour, during April, 1918, at all stations furnished with self-registering gages*—Continued.

Stations.	Date.	Total duration. From—	Total duration. To—	Total amount of precipitation.	Excessive rate. Began—	Excessive rate. Ended—	Amount before excessive rate began.	5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Lander, Wyo	1-2			1.08														*			
Lansing, Mich	28			0.27														0.19			
Lewiston, Idaho	12			0.25														0.23			
Lexington, Ky	3			0.55														0.27			
Lincoln, Nebr	19-20			0.70														*			
Little Rock, Ark	15-16	2:15 p. m.	D. N. a. m.	1.38	10:17 p. m.	10:33 p. m.	0.40	0.23	0.56	0.84	0.91										
Los Angeles, Cal	1			0.10														0.06			
Louisville, Ky	17			0.29														0.29			
Ludington, Mich	16			0.23														0.16			
Lynchburg, Va	21			0.76														0.39			
Macon, Ga	26			0.52														0.37			
Madison, Wis	28			0.50														0.17			
Marquette, Mich	17			0.42														*			
Memphis, Tenn	19-20	7:15 a. m.	6:40 a. m.	1.93	10:40 p. m.	10:55 p. m.	0.13	0.23	0.70	0.92											
Meridian, Miss	17	10:35 a. m.	3:10 p. m.	1.80	10:46 a. m.	11:16 a. m.	0.01	0.16	0.30	0.38	0.45	0.49	0.54								
Do	28	3:45 a. m.	9:15 a. m.	1.53	4:10 a. m.	5:03 a. m.	0.07	0.06	0.16	0.24	0.26	0.30	0.34	0.44	0.51	0.66	0.79	0.84			
Do	28-29	7:10 p. m.	8:30 a. m.	2.63	1:33 a. m.	3:21 a. m.	0.04	0.12	0.37	0.63	0.84	0.95	0.96	0.97	0.98	0.99	1.02	1.22	1.42	1.67	1.96
Miami, Fla	27	{10:38 a. m.	12:07 p. m.	0.83	10:52 a. m.	11:24 a. m.	0.01	0.07	0.15	0.18	0.23	0.38	0.57	0.62							
		{12:42 p. m.	2:00 p. m.	0.82	1:22 p. m.	1:41 p. m.	0.14	0.09	0.46	0.57	0.64										
Milwaukee, Wis	20-21			1.14														*			
Minneapolis, Minn	28			0.35														0.09			
Mobile, Ala	6	6:11 a. m.	11:55 a. m.	2.94	8:05 a. m.	9:13 a. m.	0.10	0.07	0.10	0.25	0.58	0.87	1.15	1.24	1.37	1.65	1.85	2.15	2.34		
Do	17	1:58 p. m.	3:55 p. m.	0.97	2:17 p. m.	2:30 p. m.	0.01	0.34	0.66	0.72											
Do	28	8:28 a. m.	10:55 a. m.	0.62	8:53 a. m.	9:18 a. m.	0.01	0.18	0.33	0.39	0.46	0.51									
Modena, Utah	2-3			0.32														*			
Montgomery, Ala	28	7:25 a. m.	11:48 a. m.	1.72	7:33 a. m.	8:05 a. m.	0.01	0.20	0.39	0.65	0.78	0.91	1.00	1.05							
Moorehead, Minn	28			1.72														*			
Mount Tamalpais, Cal	9			0.74														0.16			
Nantucket, Mass	21			1.15														0.40			
Nashville, Tenn	16			0.97														0.39			
New Haven, Conn	21			1.78														0.42			
New Orleans, La	1	5:15 p. m.	6:45 p. m.	1.93	5:47 p. m.	6:38 p. m.	0.05	0.07	0.33	0.59	0.99	1.21	1.37	1.54	1.63	1.72	1.84	1.88			
Do	17	10:35 a. m.	3:25 p. m.	1.02	11:30 a. m.	12:06 p. m.	0.12	0.11	0.40	0.54	0.58	0.63	0.65	0.75	0.77						
Do	25	6:00 a. m.	8:50 a. m.	2.06	6:28 a. m.	7:12 a. m.	0.04	0.08	0.32	0.49	0.74	0.87	1.20	1.38	1.54	1.60					
New York, N. Y	30			0.62														0.47			
Norfolk, Va	21	8:45 a. m.	11:20 a. m.	0 69	10:53 a. m.	11:06 a. m.	0.16	0.12	0.37	0.52											
Northfield, Vt	12-13			0.93														*			
North Head, Wash	13-14			0.30														0 08			
North Platte, Nebr	15			0.64														0.21			
Oklahoma, Okla	5			1.12														0.70			
Omaha, Nebr	5			0.44														0.23			
Oswego, N. Y	7-8			0.52														*			
Palestine, Tex	5	12:50 p. m.	10:55 p. m.	3.66	6:38 p. m.	7:21 p. m	1.87	0.15	0 38	0.45	0.48	0.55	0.68	0.91	1.00	1.05					
Do	15	3:05 a. m.	5:20 a. m.	1.03	3:44 a. m.	4:10 a. m.	0.03	0.15	0.35	0.55	0.68	0.83	0.88								
Do	15	6:35 a. m.	7:50 a. m.	0.84	6:59 a. m.	7:23 a. m.	0.05	0.13	0.20	0.31	0.65	0.78									
Do	27-28	11:20 p. m.	12:40 a. m.	1.10	11:22 p. m.	11:51 p. m.	0.01	0.38	0.79	0.84	0.88	0.99	1.03								
Do	28-29	9:02 p. m.	4:25 a. m.	2.22	9:04 p. m.	9:16 p. m.	0.01	0.42	0.71	0.74											
Parkersburg, W. Va	3			0.50														0.31			
Pensacola, Fla	4	7:23 a. m.	9:05 a. m.	0.89	8:01 a. m.	8:37 a. m.	0.06	0.09	0.18	0.28	0.44	0.56	0.69	0.74	0.77						
Do	6	7:40 a. m.	3:05 p. m.	1.69	11:01 a. m.	11:18 a. m.	0 31	0.27	0.48	0.57	0.62										
Do	28	9:55 a. m.	12:15 p m.	0.60	10:02 a. m.	10:26 a. m.	0.01	0.10	0.26	0.40	0.46	0.51									
Do	29	11:13 a. m.	3:07 p. m.	2.66	11:23 a. m.	12:04 p. m.	0.24	0.24	0.37	0.38	0.45	0.60	0.76	0.84	1.18	1.27					
Do	30	{2:50 a. m.	5:10 a. m.	1.83	3:49 a. m.	4:35 a. m.	0.29	0.25	0.47	0.72	0.98	1.05	1.22	1.30	1.35	1.44	1.48				
		{6:42 a. m.	12:55 p. m.	1.50	9:37 a. m.	9:48 a. m.	0.50	0.23	0.48	0.53											
Peoria, Ill	2			0.67														0.54			
Philadelphia, Pa	21			1.22														0.52			
Phoenix, Ariz	13			0.02														0.01			
Pierre, S. Dak	15			0.91														0.26			
Pittsburgh, Pa	28			0.16														0.13			
Pocatello, Idaho	13			0.39														0.13			
Point Reyes Light, Cal	9			0.52														0.15			
Port Angeles, Wash	14			0.15														0.06			
Port Arthur, Tex	5-6	10:55 p. m.	2:40 a. m.	1.30	11:05 p. m.	11:30 p. m.	0.01	0.33	0.47	0.66	0.81	0.86									
Do	17	1:05 a. m.	5:20 a. m.	1.44	1:21 a. m.	1:52 a. m.	0.02	0.06	0.33	0.27	0.39	0.54	1.00	1.03							
Do	29	9:00 a. m.	11:00 p. m.	1.41	9:54 a. m.	10:13 a. m.	0.07	0.12	0.46	0.83	0.91										
Port Huron, Mich	17			0.52														0.17			
Portland, Me	21			1.39														0.33			
Portland, Oreg	14			0.25														0.14			
Providence, R. I	21			2.16														*			
Pueblo, Colo	14			0.69														0.39			
Raleigh, N. C	20			2.08														0.38			
Rapid City, S. Dak	15			0.80														0.23			
Reading, Pa	21			1.36														0.22			
Red Bluff, Cal	9			0.37														0.19			
Reno, Nev	2			0.11														*			
Richmond, Va	21			1.16														0.59			
Rochester, N. Y	17			0.97														0.36			
Roseburg, Oreg	12			0.29														0.08			
Roswell, N. Mex	18			0.05														0.04			
Sacramento, Cal	9			0.84														0.18			
Saginaw, Mich	21			0.34														0.12			
St. Joseph, Mo	27			0.54														0.33			
St. Louis, Mo	16-17			1.82														0.58			
St. Paul, Minn	28			0.37														0.12			
Salt Lake City, Utah	2			0.29														*			
San Antonio, Tex	5	4:03 p. m.	7:16 p. m.	2.33	4:19 p. m.	5:18 p. m.	0.04	0.06	0.21	0.28	0.45	0.59	0.62	0.64	0.70	1.00	1.46	2.11			
Do	25	12:23 a. m.	1:20 a. m.	0.62	12:30 a. m.	12:45 a. m.	0.01	0.17	0.41	0.52											
Do	29	4:10 a. m.	12:40 p. m.	1.55	9:41 a. m.	9:56 a. m.	0.57	0.21	0.46	0.59											
San Diego, Cal	2			T.														T.			
Sand Key, Fla	19	3:10 a. m.	7:05 a. m.	1.10	4:41 a. m.	5:11 a. m.	0.04	0.10	0.24	0.44	0.64	0.68	0.75								
Sandusky, Ohio	20-21			0.36														0.16			
Sandy Hook, N. J	30			0.70														0.44			
San Francisco, Cal	9			0.48														0.12			
San Jose, Cal	12			0.10														0.10			
San Luis Obispo, Cal	9			0.02														0.02			
Santa Fe, N. Mex	14			0.41														*			
Sault Ste. Marie, Mich	28-29			1.04														*			
Savannah, Ga	25-26	9:30 p. m.	5:45 a. m.	2.13	12:54 a. m.	2:06 a. m.	0.62	0.07	0.16	0.24	0.30	0.34	0.40	0.49	0.58	0.70	0.81	0.98	1.19		
Scranton, Pa	8-9			0.87														*			

* Self-register not in use. † Record partly estimated. ‡ No precipitation occurred during month.

TABLE II.—*Accumulated amounts of precipitation for each 5 minutes, for the principal storms in which the rate of fall equaled or exceeded 0.25 inch in any 5 minutes, or 0.80 in 1 hour, during April, 1918, at all stations furnished with self-registering gages*—Continued.

Stations.	Date.	Total duration. From—	Total duration. To—	Total amount of precipitation.	Excessive rate. Began—	Excessive rate. Ended—	Amount before excessive rate began.	5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Seattle, Wash	14			0.35														0.08			
Sheridan, Wyo	14-15			0.85														*			
Shreveport, La	5-6	8:00 p.m.	2:15 a.m.	1.83	9:59 p.m.	10:44 p.m.	0.14	0.11	0.23	0.38	0.48	0.58	0.64	0.74	0.86	0.97					
Sioux City, Iowa	15			0.42														0.16			
Spokane, Wash	16			0.04														0.04			
Springfield, Ill	17			0.94														0.34			
Springfield, Mo	27			0.99														0.38			
Syracuse, N. Y	17			0.74														*			
Tacoma, Wash	9			0.45														0.15			
Tampa, Fla	7			0.99														0.52			
Tatoosh Island, Wash	13			0.53														0.19			
Taylor, Tex	5	3:27 p.m.	8:00 p.m.	1.11	5:27 p.m.	5:54 p.m.	0.09	0.22	0.42	0.61	0.72	0.85	0.88								
	24	9:20 p.m.	11:00 p.m.	0.74	9:43 p.m.	9:57 p.m.	0.11	0.28	0.51	0.58											
Terre Haute, Ind	2-3	6:20 p.m.	7:10 a.m.	1.35	7:15 p.m.	7:49 p.m.	0.04	0.08	0.21	0.25	0.29	0.33	0.52	0.70							
Thomasville, Ga	30	1:30 p.m.	4:18 p.m.	1.01	2:17 p.m.	2:40 p.m.	0.09	0.22	0.36	0.48	0.53	0.59									
Toledo, Ohio	28			0.45														0.38			
Tonopah, Nev	2			T.														T.			
Topeka, Kans	24			0.56														0.27			
Trenton, N. J	30			0.82														*			
Valentine, Nebr	15			0.80														0.31			
Vicksburg, Miss		5:15 p.m.	6:54 p.m.	0.79	5:55 p.m.	6:45 p.m.	0.02	0.19	0.23	0.24	0.26	0.32	0.40	0.47	0.52	0.62	0.76				
Do	6-7	9:15 p.m.	D. N. a.m.	1.57	12:01 a.m.	12:37 a.m.	0.33	0.20	0.36	0.52	0.62	0.67	0.74	0.79	0.84						
Do	18	2:26 p.m.	3:38 p.m.	0.73	2:36 p.m.	3:00 p.m.	0.02	0.16	0.37	0.42	0.60	0.69									
Do	28	12:53 a.m.	6:05 a.m.	1.64	12:58 a.m.	1:52 a.m.	0.03	0.13	0.26	0.36	0.45	0.52	0.54	0.58	0.64	0.71	0.80	0.87			
		D. N. p.m.	D. N. p.m.	1.24	10:52 p.m.	11:24 p.m.	0.01	0.28	0.59	0.75	0.95	1.09	1.20	1.23							
Walla Walla, Wash	1			0.18														*			
Washington, D. C	21			0.97														0.33			
Wausau, Wis	28			0.66														*			
Wichita, Kans	14			1.83														0.72			
Williston, N. Dak	16			1.15														0.13			
Wilmington, N. C	20	2:50 p.m.	6:35 p.m.	1.01	4:44 p.m.	5:20 p.m.	0.25	0.07	0.10	0.18	0.25	0.44	0.63	0.67	0.74						
Winnemucca, Nev	9			0.45														0.11			
Wytheville, Va	30			0.75														0.25			
Yankton, S. Dak	15			0.97														0.35			
Yellowstone Park, Wyo	22-23			0.36														*			

* Self-register not in use. † Record partly estimated. ‡ No precipitation occurred during month.

TABLE III.—*Data furnished by the Canadian Meteorological Service, April, 1918.*

Stations.	Altitude above M. S. L.* Jan., 1916.	Pressure. Station, reduced to mean of 24 hours.	Pressure. Sealevel, reduced to mean of 24 hours.	Pressure. Departure from normal.	Temperature. Mean max. + mean min. ÷ 2.	Temperature. Departure from normal.	Temperature. Mean maximum.	Temperature. Mean minimum.	Temperature. Highest.	Temperature. Lowest.	Precipitation. Total.	Precipitation. Departure from normal.	Precipitation. Total snowfall.
	Feet.	Inches.	Inches.	Inches.	°F.	°F.	°F.	°F.	°F.	°F.	Inches.	Inches.	Inches.
St. Johns, N. F	125	29.71	29.85	−0.04	35.2	+0.7	41.3	29.1	56	20	3.62	−0.54	6.0
Sydney, C. B. I	48	29.95	29.99	+ .10	35.8	+0.8	44.5	27.1	62	12	1.88	−1.97	8.0
Halifax, N. S	88	29.91	30.02	+ .06	39.6	+1.8	48.6	30.6	68	19	1.85	−2.33	6.5
Yarmouth, N. S	65	29.94	30.01	+ .05	38.9	0.0	46.3	31.5	62	23	2.31	−1.08	5.0
Charlottetown, P. E. I	38	29.97	30.01	+ .11	35.4	+0.2	41.9	28.9	60	15	1.17	−1.48	3.2
Chatham, N. B	28	30.02	30.04	+0.14	37.6	+2.1	48.0	27.2	66	15	2.21	−0.42	0.0
Father Point, Que	20	30.02	30.04	+ .11	33.5	+0.3	41.0	26.0	64	12	0.84	−0.74	0.6
Quebec, Que	296	29.73	30.06	+ .07	38.4	+3.3	47.6	29.3	67	18	1.89	−0.20	0.1
Montreal, Que	187	29.84	30.05	+ .05	42.5	+2.8	50.9	33.9	71	19	2.03	−0.21	2.1
Stonecliffe, Ont	489	29.43	30.05	+ .03	41.3	+3.4	56.0	26.7	76	10	0.69	−0.87	1.6
Ottawa, Ont	236	29.79	30.06	+0.04	43.9	+3.9	56.0	31.9	76	18	1.45	−0.05	3.0
Kingston, Ont	285	29.74	30.06	+ .04	41.1	+1.1	50.7	31.6	69	20	1.96	+0.17	2.2
Toronto, Ont	379	29.63	30.05	+ .03	43.6	+2.8	53.0	34.3	69	23	1.40	−0.97	0.8
White River, Ont	1,244	28.69	30.03	− .01	34.6	+1.6	51.6	17.6	68	1	0.91	−0.34	0.6
Port Stanley, Ont	592	29.39	30.05	+ .03	41.6	+0.6	50.7	32.5	63	22	2.03	−0.44	1.6
Southampton, Ont	656	29.32			39.2	+0.5	48.7	29.7	65	15	2.77	+0.97	3.7
Parry Sound, Ont	688	29.35	30.06	+0.04	40.9	+3.3	53.2	28.6	73	12	1.36	−0.55	4.4
Port Arthur, Ont	644	29.32	30.05	+ .02	34.5	+1.0	44.0	25.0	58	8	1.30	−0.42	T.
Winnipeg, Man	760	29.15	30.00	− .02	42.1	+6.2	54.6	29.6	74	10	1.32	+0.27	3.9
Minnedosa, Man	1,690	28.14	29.98	− .03	42.0	+6.0	55.7	28.4	73	10	0.57	−0.49	1.0
Qu'Appelle, Sask	2,115	27.68	29.94	−0.05	42.0	+4.6	55.6	28.4	75	11	1.87	+0.82	0.8
Medicine Hat, Alberta	2,144	27.63	29.92	.00	46.3	+1.8	61.8	30.8	80	13	0.17	−0.57	1.7
Swift Current, Sask	2,392	27.35	29.94	− .02	42.5	+1.2	56.4	28.6	74	12	1.06	+0.13	8.8
Calgary, Alberta	3,428	26.40	29.94	+ .04	45.3	+5.7	58.4	32.2	76	20	0.29	−0.35	0.0
Banff, Alberta	4,521	25.35	29.96	+ .06	37.9	+2.6	51.9	24.0	67	− 2	0.23	−0.85	1.5
Edmonton, Alberta	2,150	27.63	29.92	+0.03	42.2	+2.3	56.2	28.3	71	2	0.96	+0.08	4.9
Prince Albert, Sask	1,450	28.39	29.96	− .02	42.2	+6.1	55.5	29.0	74	11	1.62	+0.79	3.8
Battleford, Sask	1,592	28.19	29.94	− .03	44.5	+7.3	58.0	31.0	77	9	0.92	+0.45	1.0
Kamloops, B. C	1,262	28.76	30.07	+ .14	50.2	+1.3	64.4	36.0	80	22	0.09	−0.30	0.0
Victoria, B. C	230	29.84	30.10	+ .09	48.8	+2.0	56.3	41.3	70	33	0.35	−2.02	0.2
Barkerville, B. C	4,180	25.70	30.05	+0.19	34.4	+1.3	45.5	23.3	60	1	0.91	−0.91	6.3
Hamilton, Bermuda	151	29.93	30.09	+ .04	65.2	+1.3	70.3	60.2	75	53	8.80	+4.62	0.0

* See explanation of tables, this REVIEW for January 1918, p. 48.

Chart I. Hydrographs of Several Principal Rivers, April, 1918.

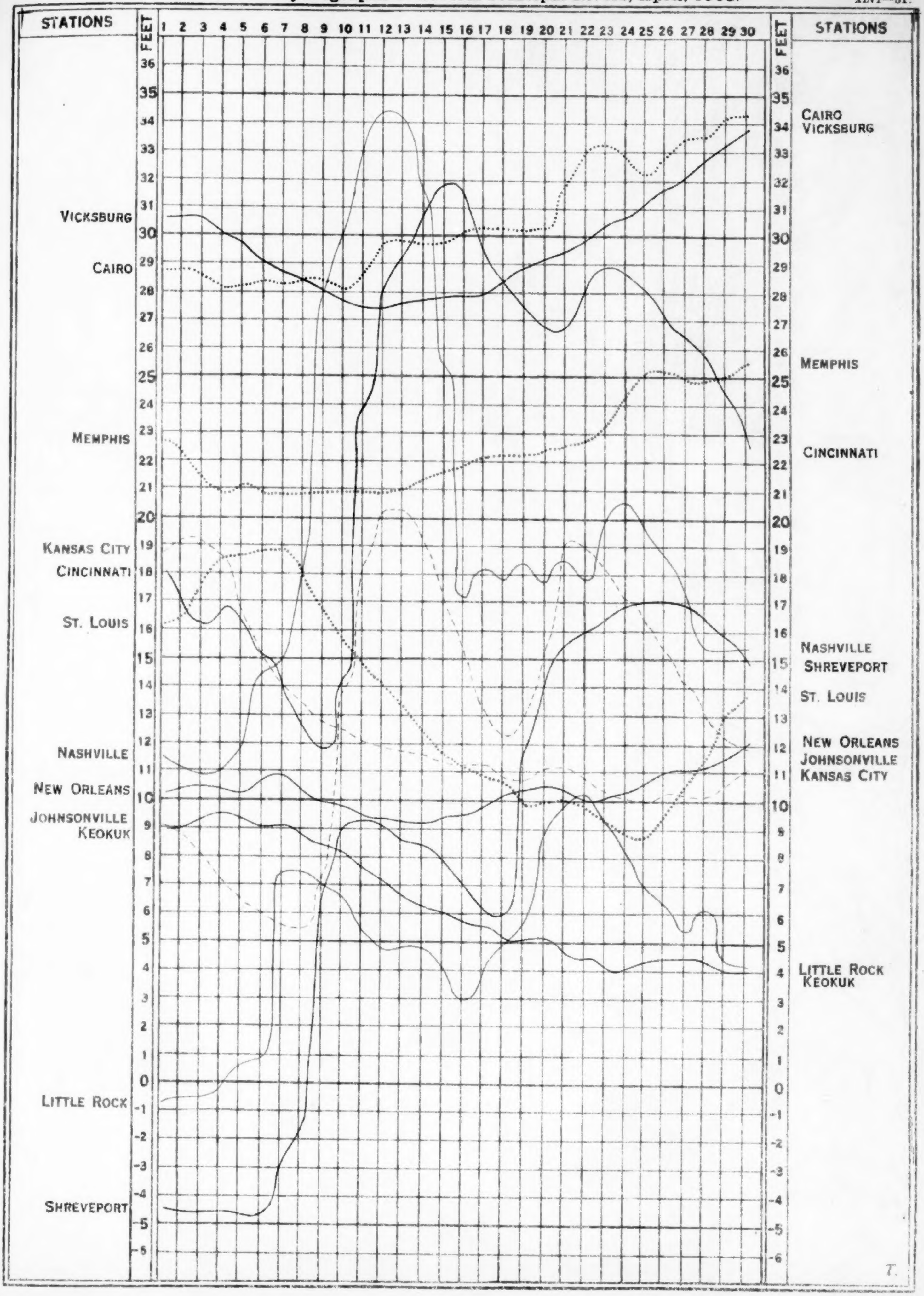


Chart II. Tracks of Centers of High Areas, April, 1918.

(Plotted by Charles A. Donnel.)

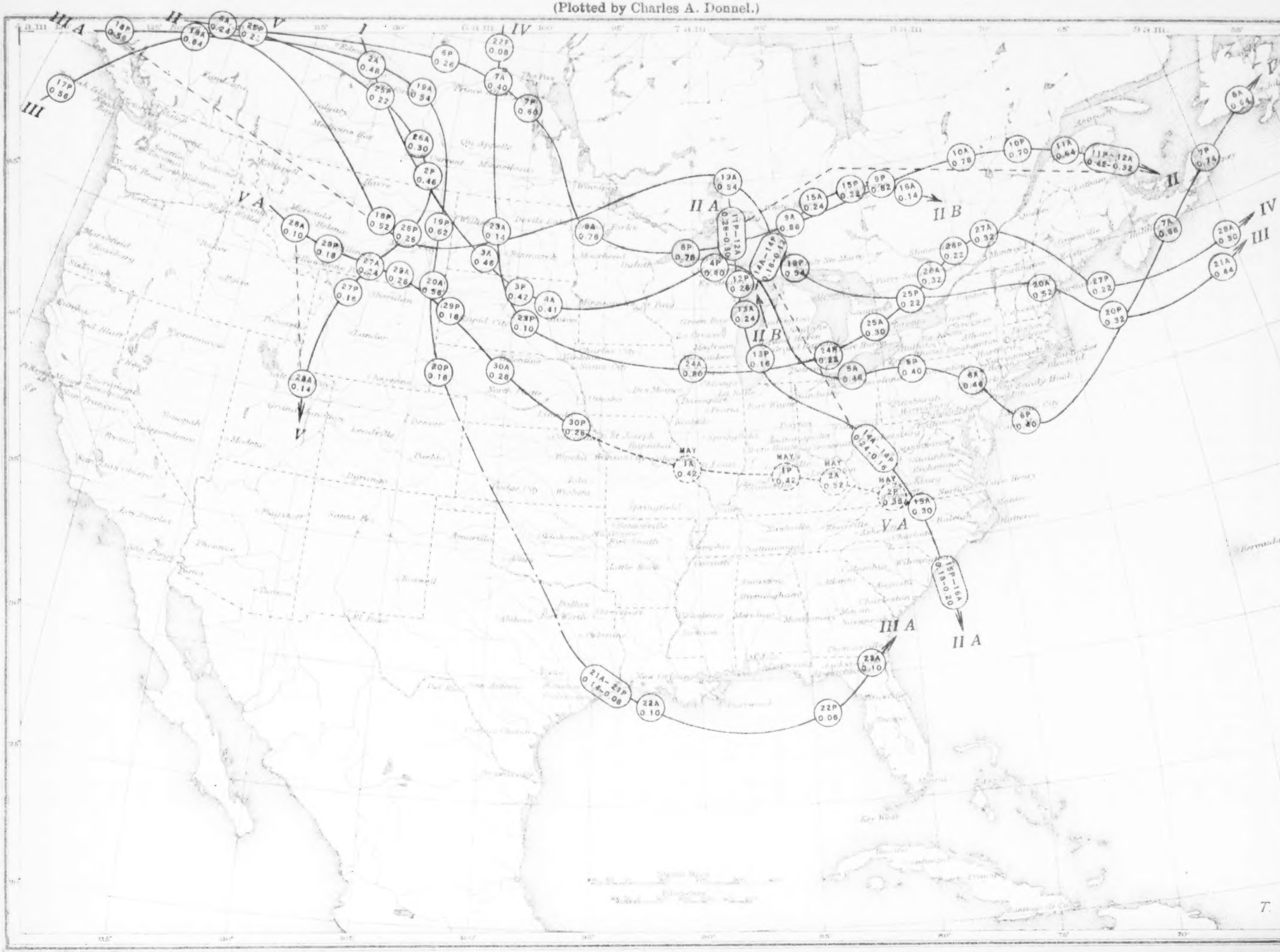


Chart III. Tracks of Centers of Low Areas, April, 1918.

Chart III. Tracks of Centers of Low Areas, April, 1918.
(Plotted by Charles A. Donnel.)

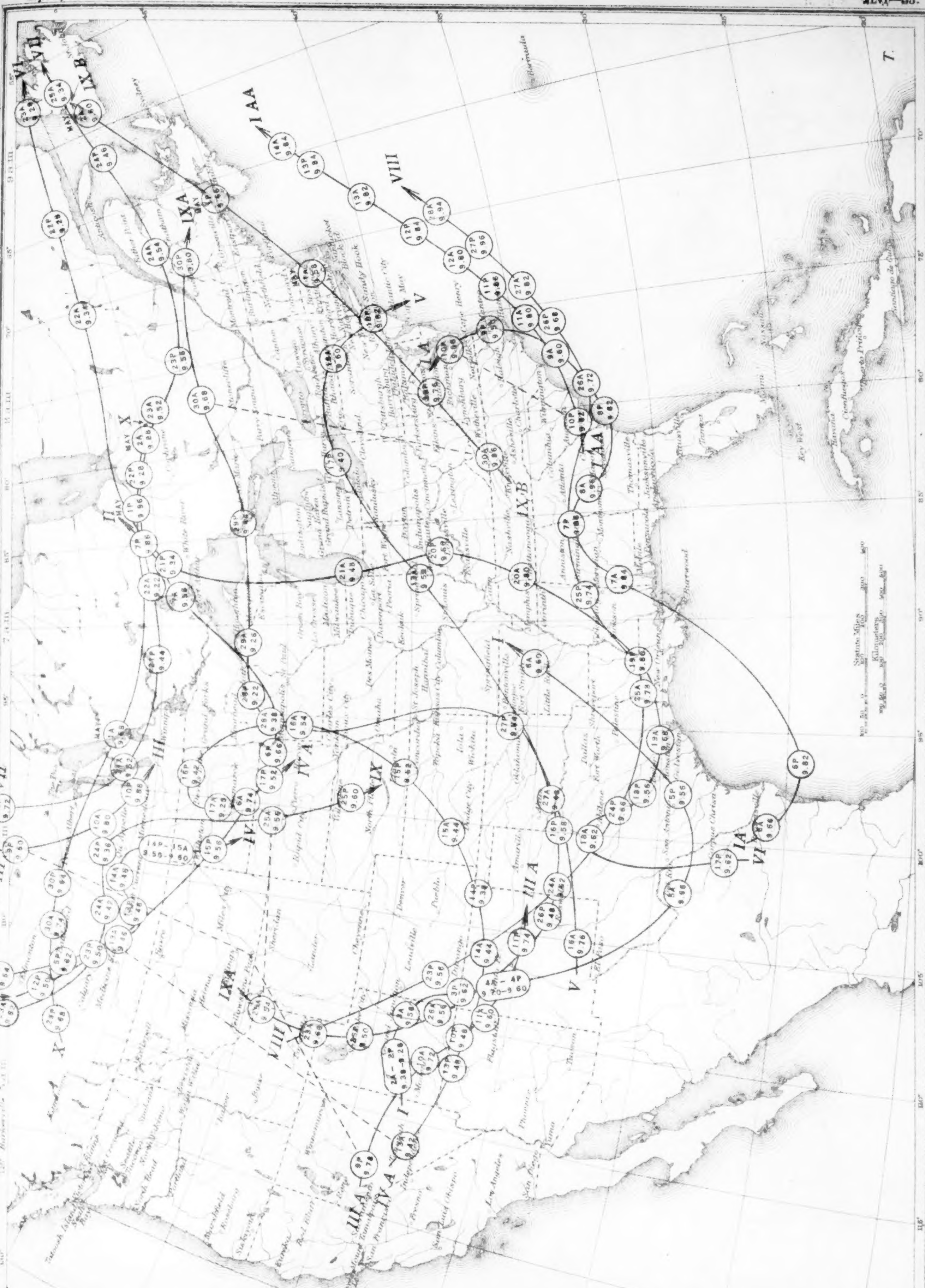
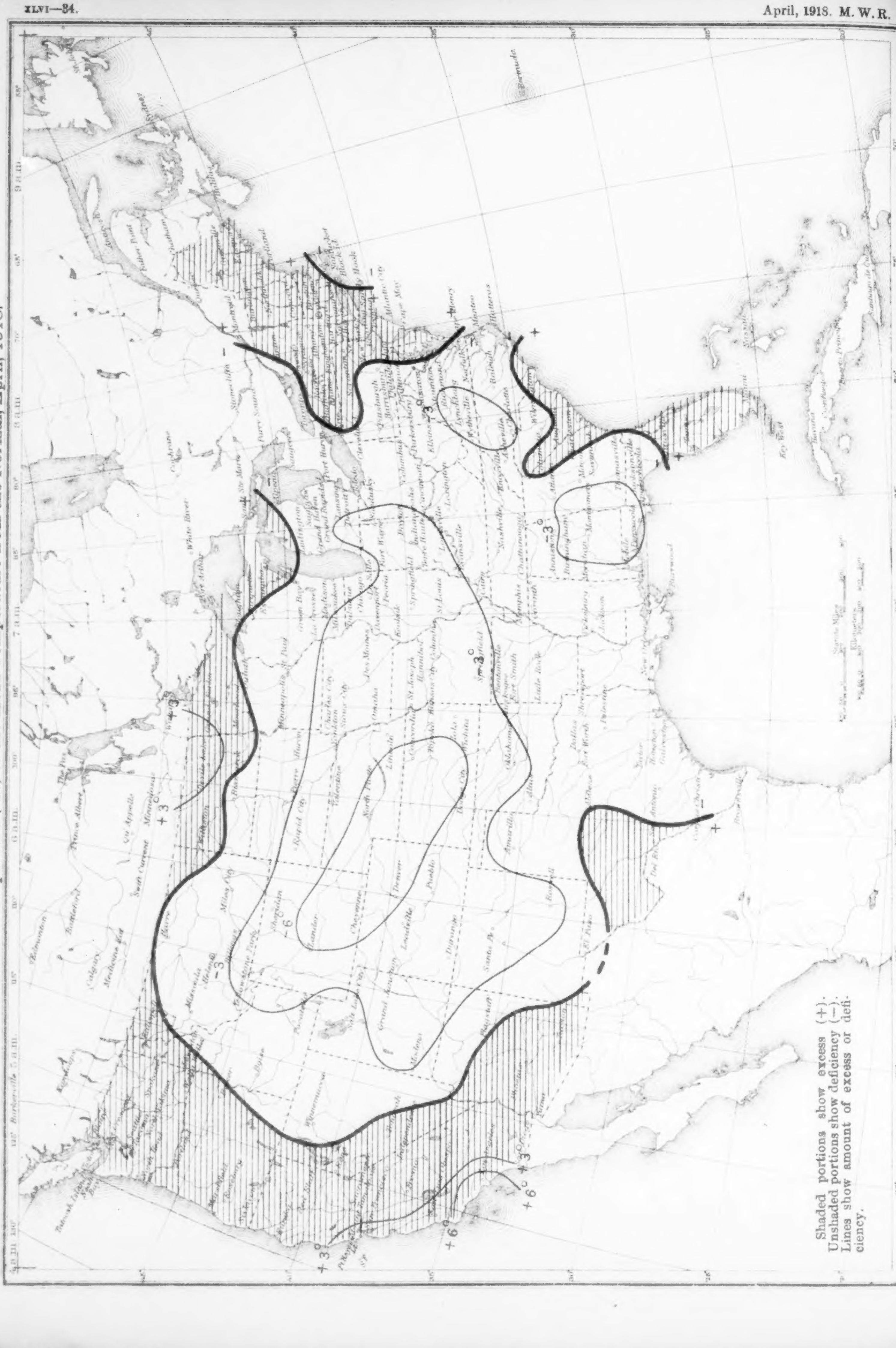


Chart IV. Departure (°F.) of the Mean Temperature from the Normal, April, 1918.



Shaded portions show excess (+).
Unshaded portions show deficiency (−).
Lines show amount of excess or deficiency.

Chart V. Total Precipitation, April, 1918.

Chart V. Total Precipitation, April, 1918.

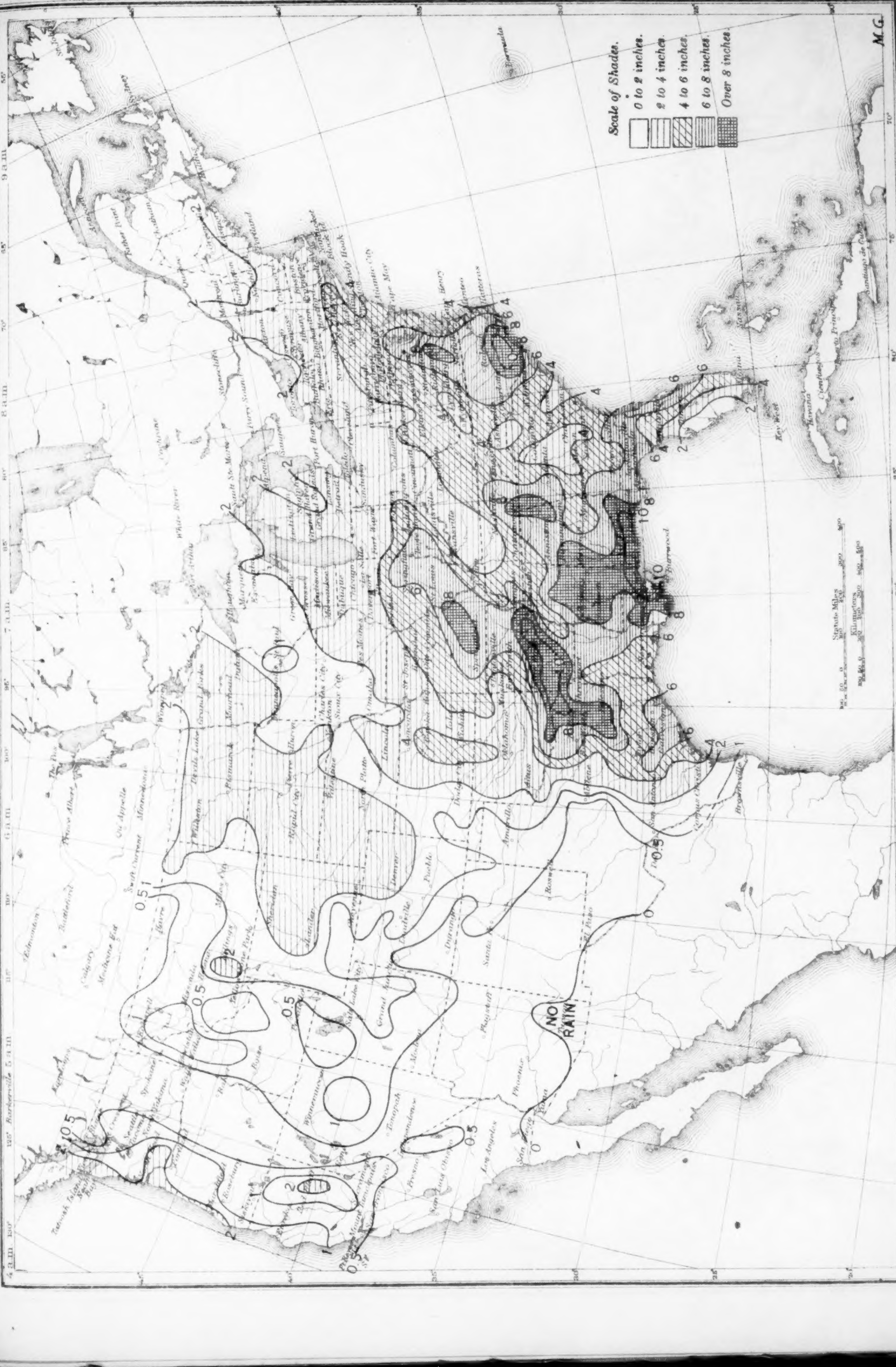
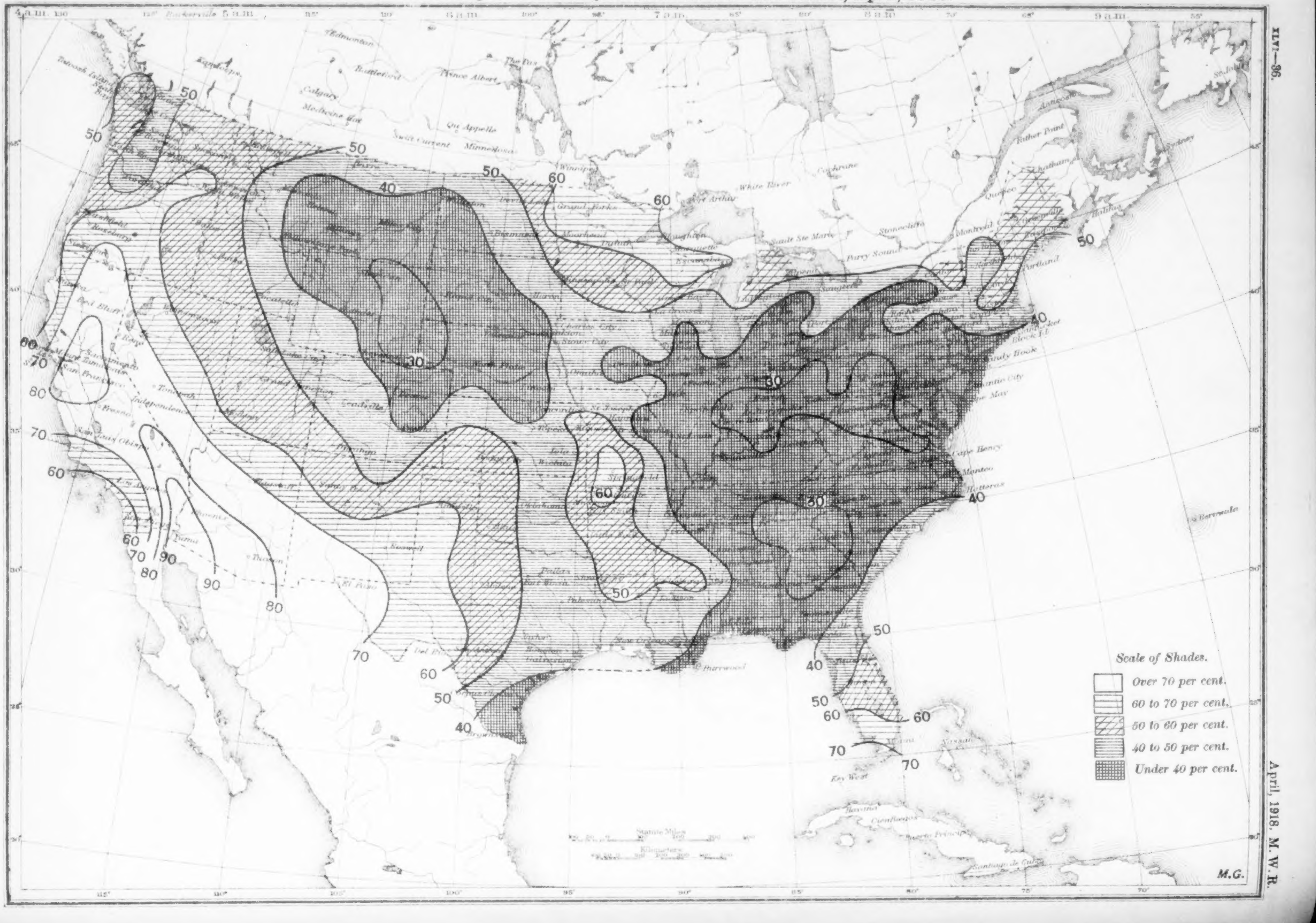


Chart VI. Percentage of Clear Sky between Sunrise and Sunset, April, 1918.



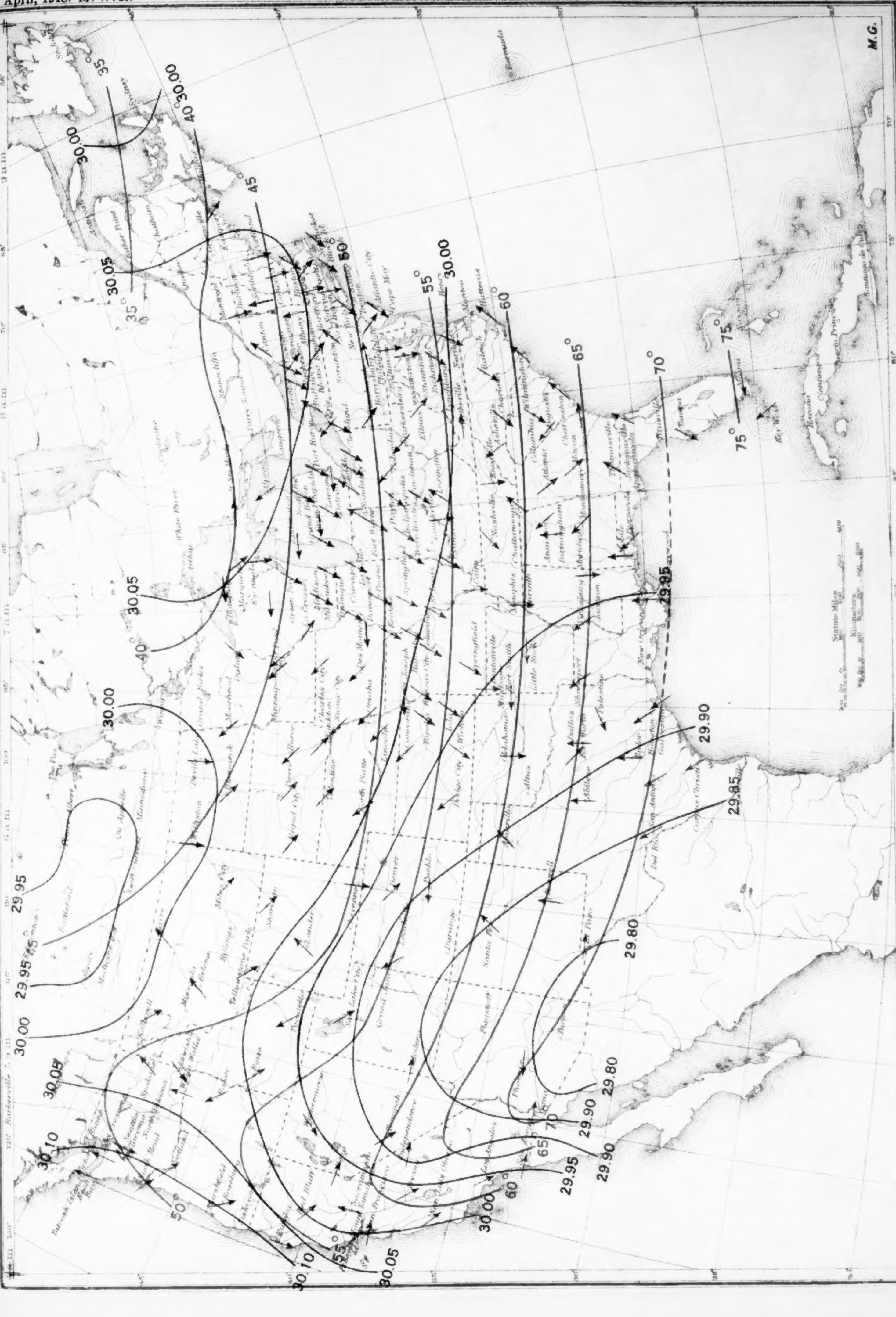
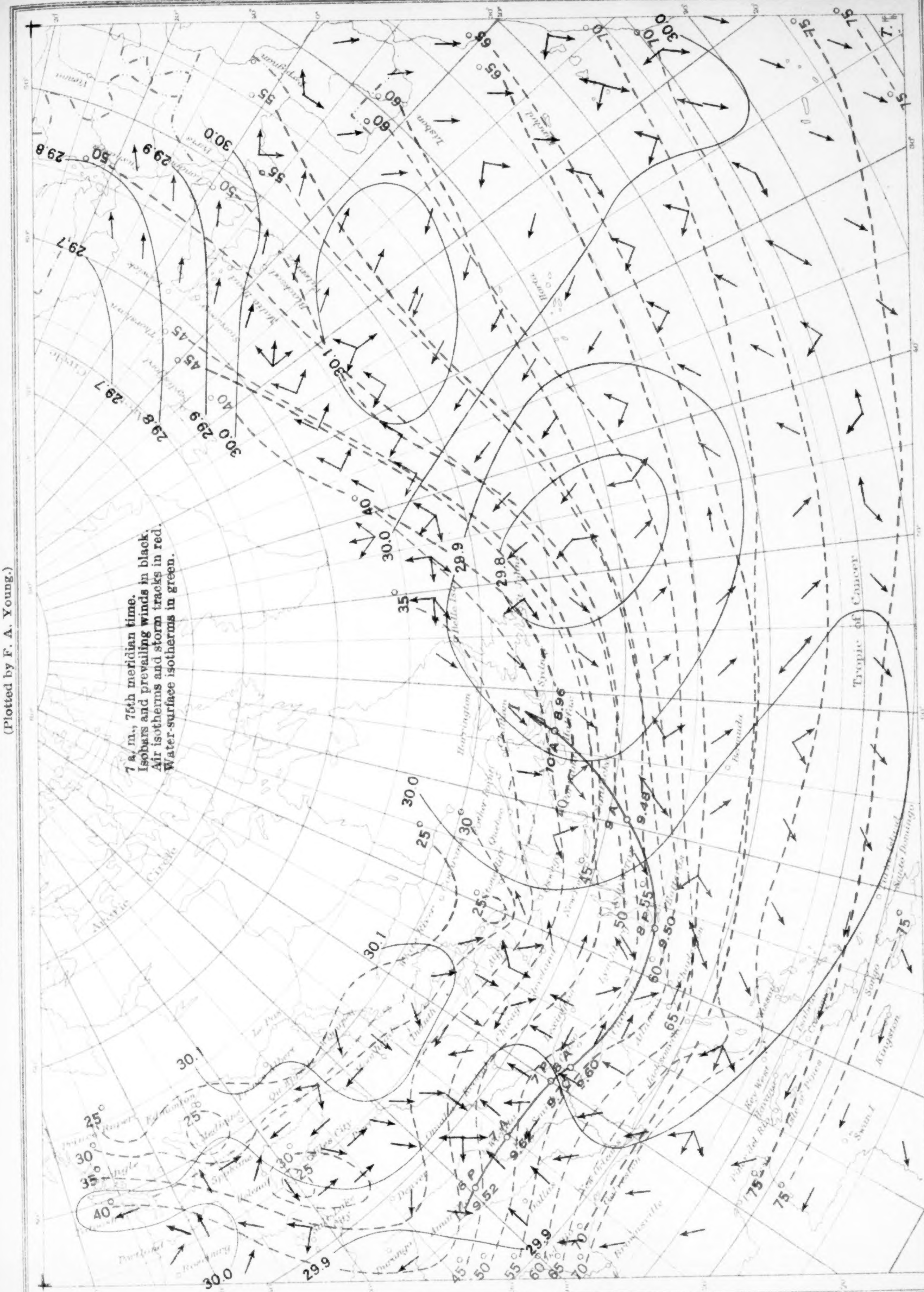


Chart VII. Isobars and Isotherms at Sealevel; Prevailing Winds, April, 1918.

Chart VIII. Total Snowfall, Inches, April, 1918.

Chart IX. Means of Meteorological Data for North Atlantic Ocean, April, 1917.

Chart IX. Means of Meteorological Data for North Atlantic Ocean, April, 1917.
(Plotted by F. A. Young.)



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